BRAIN MAGNETIC RESONANCE IMAGING FINDINGS AMONG PAEDIATRIC PATIENTS WITH SEIZURE DISORDERS ATTENDING MUHIMBILI NATIONAL HOSPITAL

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By

Beatrice E. Ndossi

A Dissertation Submitted in (partial) Fulfillment of the Requirement for the Degree of Master of Medicine (Radiology and Imaging) of

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CERTIFICATION

The undersigned certify that he has read and hereby recommend for acceptance by Muhimbili University of Health and Allied Sciences a dissertation entitled *"**Brain magnetic resonance imaging findings among paediatric patients with seizure disorder at Muhimbili National Hospital, Dar es salaam,Tanzania March-September-2017"*** in (partial) fulfillment of the requirement for the degree of Master of Medicine (Radiology) of Muhimbili University of Health and Allied Sciences.

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Dr. Balowa Musa Baraka

(Supervisor)

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Date

DECLARATION AND COPYRIGHT

I, **Beatrice Ndossi**, declare that this **dissertation** is my own original work and that it has not been presented and will not be presented to any other university for similar or any other degree award.

Signature……..... **Date**…….....

AKNOWLEDGEMENT

I would like to express my sincere gratitude to the Almighty Lord, for the grace and mercy bestowed upon me until today.

Special thanks to my superviser Dr Balowa Musa Baraka, for curving the way for me, for I had an idea, he showed me the way. Thanks for all the guidance, mentorship and constructive criticism, you made this dissertation possible.

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Special thanks to the Radiology department at MNH especially the MRI team for their unfailing support, teamwork and encouragement and special care when the going got tough.

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DEDICATION

For Luna Michelle Musiime

It was a bitter sweet experience, but through it all, you made it worthwhile.

Love, mom.

ABSTRACT

Background

Paediatric seizures are a common problem in developing countries including Tanzania. However little information is available regarding the aetiology of seizures in our society.

There are several causes of seizures ranging from congenital, infectious, tumors, vascular to unknown causes where by precise identification is a key to the long term management and control of seizure disorder.

MRI is the most advanced crosssectional imaging modality which has enabled identification of several causes of seizure from congenital, infectious, tumours, vascular to structural causes.

This study aims to investigate the patterns of MRI findings in children presenting with seizures at Muhimbili National Hospital, Dar es salaam , Tanzania and to characterise the demographic patterns of identified lesions associated with seizures in these children.

Broad objective

To determine patterns of MRI findings associated with seizure disorders among paediatric patients at Muhimbili National Hospital from June 2016 to December 2016.

Methodology

This is a descriptive cross sectional study which was conducted at the Radiology department, Muhimbili National Hospital from June to December 2016. Children presenting with seizures referred for brain MRI were included in the study. Consent was obtained for children who met inclusion criteria for the study from their parents/guardians. Formal ethical approval was obtained from the Muhimbili university of Health and Allied Sciences Senate Research and Publications Committee. Structured questionnaires were used for recording patients' demographics, and imaging findings. Data analysis was done using the Statistical Package for Social Sciences (SPSS) version 23. Statistical Association was done by using cross tabulations and Chi-square test was used to compare proportions. P value of < 0.05 was considered statistically significant.

Results

The median and mean age of the study participants was 6.8 and 5 years respectively with a range of 1 to 17 years . Prevalence of seizures was more in males compared to females (62.9%), and the most affected age group was those below 5 years old.

Tonic clonic seizures were the commonest seizure pattern in all age groups observed in this study followed by partial seizures, and status epilepticus.

More than half of the seizures (53.2%) were spontaneous. Birth associated problems(birth asyphyxia, trauma), meningitis, and trauma were the commonest risk factors associated with seizure disorder.

The most common findings were Infarct (8.1%), encephalomalacia (6.5%), congenital anomalies (4.8%), Gliosis and hydrocephalus (4.8%). There was no significant relationship of these patterns with seizure type observed

Conclusion

Abnormal findings were found in 41.9% of patients in this study. Although there was a significant number of normal MRI found, investigation of seizures in children is mandatory for proper management planning.

Recommendations

MRI is a safe and efficient imaging tool, I recommend all children presenting with seizures to be investigated thoroughly using this tool.

I reckon for more studies regarding seizures in our society to be done to include bigger sample sizes and multidisciplinary approach.

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LIST OF ABBREVIATIONS

MNH	Muhimbili National Hospital
MRI	Magnetic resonance imaging
Tsh	Tanzanian shillings
Fig	Figure
SPECT	Single photon emission computed tomography
EEG	Electroencephalogram
PET	Positron Emision Tomography
CT	Computed Tomography
ADC	Apparent Diffussion Coefficient
FLAIR	Fluid Attenuation Inversion Recovery
DW/DWI	Diffussion Wighted Imaging
CNS	Central Nervous System

DEFINITION OF TERMS

Used in MRI Findings

Cerebral atrophy: Characteristic features include prominent cerebral sulci (i.e. cortical atrophy) and ventriculomegaly (i.e. central atrophy) without bulging of the third ventricular recesses. (1)

Hippocampal sclerosis: decreased hippocampal volume secondary to neuronal loss, and increased hippocampal T2 signal likely reflecting gliosis. (2)

Periventricular leukomalacia: MRI demonstrates characteristic T1 hyperintensity and variableT2 intensity. Injury to white matter generally results in T1 hypointensity and T2 hyperintensity due to ischemia-induced edema.(3)(4)

Tuberous sclerosis: Cortical tubers have high signal intensity on T2-weighted images and low signal intensity on T1-weighted images.(5)

Radial white matter bands at MR imaging, appear as thin straight or curvilinear bands of hyperintensity on T2-weighted images and iso- to hypointensity to normal white matter on T1-weighted images run from ventricular or juxtaventricular white matter to the deep surface of cortical tubers or normal-appearing cortex. (5)

Superficial white matter abnormalities are seen as high-intensity areas on T2-weighted images and decreased-intensity areas on T1-weighted images.(5) White matter cyst like lesions are located in deep white matter, typically near the lateral ventricles and at MR imaging, small well-demarcated lesions of similar intensity to that of cerebrospinal fluid with all sequences are seen in white matter.(5)

Polymicrogyria: Numerous small gyri, predilection for Sylvian fissure, atrophy mainly posteriorly, anomalous venous drainage in areas of polymicrogyria (6)

Heterotopia: Heterotopia present as nodular foci of grey matter intensity on all sequences. They do not enhance.(7)

Ganglioglioma: Typically presents as cyst with enhancing mural nodule, but may be entirely solid Calcification.T1 solid component iso to hypointense solid component shows variable contrast enhancement(8). T2 hyperintense solid component variable signal in the cystic component depending on amount of proteinaceous material or presence of blood products Peritumoral FLAIR/T2 edema is distinctly uncommon.T2* (GE/SWI) calcified areas (common) will show blooming signal loss (8)

Focal cortical dysplasia: Subcortical white matter hyperintensities at the bottom of a deep sulcus, blurred grey-white matter interface, focal cortical thickening, hyperintensity extending from the subcortical area to the margin of the ventricle (transmantle sign)(9)(10)

Meningitis: diffuse or patchy meningeal thickening, hyperintensity in FLAIR and post contrast enhancement.(11)

Cerebral infarction: Infarction is a permanent injury that occurs when tissue perfusion is decreased long enough to cause necrosis, typically due to occlusion of the feeding artery

ADC the signal intensity is low in all acute phases and high in chronic phase. (12)

DW images, all acute phases the signal intensity is high and variable signal intensity in a chronic phase. (31)

FLAIR, the early hyperacute phase may show variable signal intensity, other acute phase have high signal and variable signal in chronic phase. (12)

In T1, the early hyperacute phase may show isointense signal while other acute phases may show low signal and high signal is seen in chronic phase. (12)

In T2 images, there is a high signal intensity in all phases and Isointense and variable signal in early hyperacute and late hyperacute phases respectively. (12)

Tuberculoma: tuberculomas may be high or low in signal intensity on T2WI, depending upon the size of the lesion and the water content of the caseous necrosis. The wall of the tuberculoma is often hypointense on T2WI. There is significant enhancement after gadolinium

administration, with a solid nodular or thick ring-shaped appearance. There may or may not be increased signal intensity centrally on DWI. Surrounding edema is often relatively mild.(1)

Cerebritis:
Early: the lesion is hypointense or isointense on T1WI and hyperintense on T2WI and FLAIR images. There may be mild mass effect and patchy areas of enhancement within the lesion(13)

Late: hypointensity on T1WI, and hyperintensity on T2WI and FLAIR sequences on MR. DWI may show some increased signal intensity within the center of the lesion. Delayed contrast images may show some late central enhancement(13)

Neurocystcercosis: In the vesicular stage, viable parasitic cysts appear as small, solitary or multiple rounded lesions that are isointense to Cerebrospinal fluid. There is usually no enhancement or edema.(14)

Colloid stage: ring-enhancing lesions with surrounding vasogenic edema (14)

Nodular granular stage: the dead cyst becomes smaller and causes less edema, but shows increasing nodular or irregular peripheral enhancement.
Nodular calcified stage: a dense residual calcification is left with no remaining edema or enhancement. The calcifications are best seen on T2*-weighted gradient-recalled echo (GRE) sequences. (14).

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Paediatric seizure disorders are a common problem in developing countries including Tanzania. (15). According to the WHO, up to 10% of people worldwide have one seizure during their lifetime. The estimated proportion of the general population with seizures at a given time is between 4 and 10 per 1000 people and poses a clinical and social problems to the child and the family as a whole.(16) In low- and middle-income countries the proportion is much higher, between 7 and 14 per 1000 people.(16)

Generalized tonic clonic seizure disorders are a more predominant clinical seizure pattern than the partial seizures and simple partial seizures are slightly more frequent than the complex partial seizures as described in several studies.(17)(18)

There are several causes of seizure disorders ranging from congenital, infectious, tumors,trauma, fever, vascular to unknown causes where by precise identification is a key to the long term management and control of seizure disorder.(19) The etiological factors of epilepsy differ markedly in children as compared to adults.(20)

Seizure disorders are common among male children below 10 years; and slightly higher among females in children with ten years and above (3). Most of paediatric seizures were associated with fever and specifically highest in children below 5yrs; and this association decrease with increasing age (3).

Seizures are caused by cerebrocortical hyperactivity, partial onset seizures begin in localized area of cerebral cortex.(20) Less than one third of seizures in children are caused by epilepsy, a condition in which seizures are triggered recurrently from within brain. Lesions in temporal lobe are probably most likely to cause seizures(20)

Central nervous system (CNS) infections and infestations are the main cause of seizures and acquired epilepsy in the developing world.(17) In the developed regions hypertensive encephalopathy, intracranial hemorrhage, congenital malformations and brain tumors are the commonest causes.(21) Geographical variations determine the common causes in a particular region.(17)

Role of imaging is to localize the origin of focal seizure and identify its cause. This information is important in treatment and prognosis of affected patients. Several investigative modalities for assessment of children with seizures that include EEG, Computed Tomography, MRI, PET MRI, SPECT MRI among others are can be utilised depending specific indications and availability.(20)

MRI is the most advanced cross sectional imaging modality and has enabled identification of several causes of seizure from congenital, infectious, tumours, vascular to structural causes. However in some other aspects no known cause can be identified.(22)

Most studies have shown partial seizures in childhood are associated with brain lesion on imaging as compared to generalized seizures(4).Tuberous sclerosis, dysembryoplastic neuroepithelial tumor [DNET], ganglioglioma and astrocytoma were the findings in these patients with partial seizures respectively.(5)

The objective of this study was to determine patterns of MRI findings associated with seizure disorders among paediatric patients at Muhimbili National Hospital from June 2016 to December 2016. The findings of this study will help develop MRI guidelines for paediatric patients presenting with seizure disorders at MNH.

1.2 Literature Review

Seizures are one of the common neurological disorders in paediatric population worldwide (9,10,11). In western countries between 2% and 4% of underfive children (23); and 4 -10% of children in the first 16 years (5); experience at least one seizure episode. The frequency **is** highest in under three year olds and decreases with age (24). In Africa the seizure disorder occured in 0.5 -3.7% of paediatric population (25).

Seizure disorder is common among male children below 10 years (10,3,4,12); and slightly higher among females in children with ten years and above (17)(26).

Generalised tonic clonic seizures are a more predominant clinical sizure pattern than the partial seizures as described in several studies (3,4,13) and simple partial seizures are slightly more frequent than the complex partial seizures (18).

Etiological factors for seizures are several and widely varied from region to region (3,14,4). In the developing world infections and infestations are among the leading causes of seizures whereas in the developed regions hypertensive encephalopathy, intracranial hemorrhage, congenital malformations and brain tumors are the commonest cause. (21,27).

Most of paediatric seizures are associated with fever and specifically highest in children below 5 years; and this association decreases with increasing age (17, 23)

Central nervous system infections are the main cause of seizures and acquired epilepsy in the developing countries with neurocysticercosis and neurotuberculosis being common causes of epilepsy in tropical countries and particularly in India (3,7,16,17)

Malaria, respiratory infections and pyogenic meningitis are found to the commonest causes of seizures in Kenya (28); while respiratory tract infections followed by malaria are leading causes of seizures in Tanzania (29).

MRI being more sensitive than computed tomography(CT) is the technique of choice to identify underlying cause in seizures due to superior soft tissue resolution and ability to image in different planes and sequences, and in addition it has no radiation dose to the patient (30)(31).

Studies have shown several most common MRI findings associated with seizures vary from region to region (10,13,17,19). Abnormal MRI imaging findings varies as reported in several studies ranging from 11% to 53% (30)(32)(33)(34)

Most studies have shown partial seizures are associated with brain lesion on imaging (10,17)(29). Abnormal MRIs **are** observed among 53% **of** patients with partial seizures in Nigeria (30). The commonest **is** diffuse brain atrophy among children with birth related insults in Nigeria(18).

Tuberous sclerosis, dysembryoplastic neuroepithelial tumor [DNET], ganglioglioma and astrocytoma are the most common findings in patients with partial seizures respectively.(17)

Cerebral infarct **is** another common cause of seizures observed in imaging (22,23(36).

Seizures have been associated with intracranial tumors, vascular abnormalities, chronic subdural haematoma and hydrocephalus in one study done in Nigeria. (30). Others are depressed skull fractures contusions and subdural collections and these indicated abuse towards young children (30).

The abnormal findings have been shown to increase with age, and these structural abnormalities also vary with age. In the under 5 the most common lesion is intracranial tumors and vascular pathologies.Vascular lesions, hydrocephalas and tumors are the most common findingsin the 5 to 11 years group whereas in teenagers tumors, brain atrophy and encephalomalacia were the observed lesions (13,4)

In the under 5 years group, cerebral dysgenesis, dysgenesis of corpus callosum, band heterotopia, cortical dysplasias like Dandy walker malformation,lissencephaly,

polymicrogyria, schizencephally and tuberous sclerosis are common (37). Cerebral dysgenesis was associated with non febrile seizures in infants 1 to 24 months (37).

Ventricular enlargement, (51%), leucomalacia/gliosis (23%), gray matter lesions(12%), volume loss (atrophy),(12%) white matter lesions(9%) and encephalomalacia (12%) have been reported in various studies as most common MRI patterns. White matter abnormality has also been reported to be the leading cause of abnormality 10.4%.(23,25)

In partial seizures, hippocampal lesions are the most common. Cerebellar atrophy has been associated with chronic seizures.(25,21)

The most common MRI findings associated with hippocampal in children are decreased hippocampal volume secondary to neuronal loss, and increased hippocampal T2 signal likely reflecting gliosis.(39) Visual assessment of asymmetry in hippocampal volumes has been shown to be 86% sensitive and 83% specific in detecting hippocampal sclerosis.(2) Hippocampal volume loss can be a generalized process (affecting the entire structure),or segmental. Abnormally increased T2 signal has been reported to be 93% sensitive and 74% specific in predicting hippocampal sclerosis. Bilateral hippocampal sclerosis occurs in approximately 3% to 10% of patients.(2)

Additional ancillary findings include enlarged temporal horn of lateral ventricle (79%) and decreased ipsilateral temporal lobe size (65%).(2)

Coronal fluid attenuated inversion recovery (FLAIR) images allow for identification of subtle hippocampal signal alterations and additional lesions. Gadolinium administration is not routinely needed in these patients unless a tumor is suspected.

Periventricular leukomalacia is a finding associated with hypoxic-ischemic brain injury in the preterm neonate secondary to ischemic, infectious, or metabolic insults.(40) Hypoxic ischemic injury to gray matter (deep gray matter, cortex) demonstrates characteristic T1 hyperintensity and variableT2 intensity, depending on the time at imaging and the dominant underlying

pathologic condition, such as hemorrhage or gliosis. Injury to white matter generally results in T1 hypointensity and T2 hyperintensity due to ischemia-induced edema.(3)

Cerebral infarction, another common finding, may be classified and dated as early hyperacute, late hyperacute, acute, subacute, or chronic.(12) In ADC the signal intensity is low in all acute phases and high in chronic phase. In DW images, all acute phases the signal intensity is high and variable signal intensity in a chronic phase. The same pattern is also seen in FLAIR, in which however, the early hyperacute phase may show variable signal intensity. In T1, the early hyperacute phase may show isointense signal while other acute phases may show low signal and high signal is seen in chronic phase. In T2 images, there is a high signal intensity in all phases and Isointense and variable signal in early hyperacute and late hyperacute phases respectively.(12)

Tuberous sclerosis (TS) is an autosomal dominant inherited neurocutaneous syndrome characterized by a variety of hamartomatous lesions in various organs. A variety of intracranial manifestations of TS are known. Four common CNS abnormalities are cortical tubers, subependymal nodules, subependymal giant cell astrocytoma (**SEGA**), and white matter abnormalities. (5)

Cortical tubers have high signal intensity on T2-weighted images and low signal intensity on T1-weighted images. Only 10% of cortical tubers show enhancement with contrast material. In neonates and infants with cortical tubers, some nodules can be demonstrated only on T1-weighted images. Calcification and central cystic degeneration can sometimes occur. Subependymal nodules are hyperintense on T1-weighted images and iso- to hyperintense on T2-weighted images.(5)(41)

White matter abnormalities in patients with TS include superficial white matter abnormalities associated with cortical tubers, radial white matter bands, and cyst like white matter lesions.(5) Radial white matter bands at MR imaging, appear as thin straight or curvilinear bands of hyperintensity on T2-weighted images and iso- to hypointensity to normal white matter on T1-

weighted images run from ventricular or juxtaventricular white matter to the deep surface of cortical tubers or normal-appearing cortex. (5)

Superficial white matter abnormalities are seen as high-intensity areas on T2-weighted images and decreased-intensity areas on T1-weighted images.(5) White matter cyst like lesions are located in deep white matter, typically near the lateral ventricles and at MR imaging, small well-demarcated lesions of similar intensity to that of cerebrospinal fluid with all sequences are seen in white matter.(5)

The ability to recognise neurological disorders and indicate possible underlying pathology as basis for pediatric seizures requires thorough clinical and radiological evaluation.(30) Role of imaging is to localise the origin of seizure and identify its cause. This information is important in treatment and prognosis of affected patients (22)

The introduction of MRI into clinical practice has substantially revolutionalised the evaluation and management of epilepsy and seizures disorders.(20). MRI being more sensitive than computed tomography(CT) is the technique of choice to identify underlying cause in seizures due to superior soft tissue resolution and ability to image in different planes and sequences, and in addition it has no radiation dose to the patient.(6,13,22,24,34)

This aim of this study is to determine MRI findings **in** children with seizures, to identify the common causes of seizures in our society and the demographic patterns of seizures, risk factors and their associations.

The findings of this study will help develop MRI guidelines for paediatric patients presenting with seizure disorders at MNH.

1.3 Problem Statement

Seizure disorders are common in our society. Yet little data exists regarding the common aetiology of seizure disorders in Tanzania.

Seizure disorders are a medical emergency and may be life threatening. There are various causes of seizure disorders in paediatric age group in our environment with infections, structural lesions and tumors of childhood being among the causes. If not properly investigated, poor management of seizure disorders follows as a consequence, which may lead to permanent disabilities and even death.

In Tanzania, **little** is known about the findings of brain MRI done for seizure disorders. MRI has been performed to many patients refered for seizure disorder at The Muhimbili National Hospital. The pattern of the findings is less known so this study aims to characterise the imaging patterns associated with seizure disorder.

The findings of this study will help develop MRI guidelines for paediatric patients presenting with seizure disorders at MNH

1.4 Rationale

Seizures in children are common and affect the health of the child, the family and community as a whole. Seizures can be debilitating and may also lead to death where appropriate action is not taken. Little is known in Tanzania with regards to imaging findings **in** the children with seizures.

Therefore the aim of this study was to determine MRI findings **in** children with seizures, to identify the common causes of seizures in our society and the demographic patterns of seizures. The study is going to establish baseline data to be used in future research planning in Radiology and neurology/ neurosurgery /pediatric departments.

1.5 Research Question

1. What are the findings of MRI in pediatric patient with seizures undergoing brain MRI at MNH?
2. What are the demographic patterns associated with these MRI findings?
3. What are the most common seizure patterns among pediatric patients with seizure undergoing brain MRI at MNH?
4. What are the most common risk factors for seizure among pediatric patients with seizure disorder undergoing brain MRI at MNH?

1.6 Objectives

1.6.1 Broad Objectives

To determine Magnetic Resonance Imaging findings among paediatric patients with seizure disorders attending Muhimbili National Hospital from June 2016 to December 2016

1.6.2 Specific Objectives

1. To determine MRI findings among pediatric patients with seizure disorders undergoing brain Magnetic Resonance Imaging at Muhimbili National Hospital
2. To determine sociodemographic factors among pediatric patients with seizure disorders undergoing brain Magnetic Resonance Imaging at Muhimbili National Hospital from June 2016 to December 2016
3. To determine the risk factors of seizure among pediatric patients with seizure disorders undergoing brain Magnetic Resonance Imaging at Muhimbili National Hospital from June 2016 to December 2016
4. To determine seizure patterns among pediatric patients with seizure disorders undergoing brain Magnetic Resonance Imaging at Muhimbili National Hospital

CHAPTER TWO

2.0 METHODOLOGY

2.1 Type of study

The study was a descriptive cross sectional hospital based study

2.2 Study duration

The study was conducted from June 2016 to December 2016.

2.3 Study area

The study was conducted at the radiology department of Muhimbili National Hospital. Muhimbili National Hospital is the most specialized hospital in Tanzania and it receives referrals from all over the country. It is the only government owned facility with capabilities of carrying out MRI studies in the country.

2.4 Study population

The study included children presenting with seizures referred to radiology department for MRI of the brain examination.

2.5 Inclusion criteria

Children from the age of **0 to 17 years** presenting with seizures

2.6 Exclusion criteria

Children with neurological symptoms but no history of seizures

2.7 Patients involved

All children who fulfilled the inclusion criteria and parents signed the consent form.

2.8 Sampling method

Convenience sampling method was used.

All children with seizure disorders who were investigated at the MRI department at Muhimbili National Hospital were consecutively enrolled until the sample size reached.

2.9 Sample size

The sample size calculated from Fisher's formula;

$n=Z^2P\ (1-P)/E^2$

Where: n= sample size,

Z = (1.96)

P = prevalence 3.7% This was the prevalence of seizures in the pediatric population in Nigeria (25)

95% confidence interval was used.

E = margin error 5%

Therefore $n= (1.96)^2 \times 0.037\ (1 - 0.037)/ (0.05)^2 =54.75$

We sampled an extra 5% to account for possible non-response

n= 55 + 3 (5% of 55)

Thus the sample size in this study was 58 children.

2.10 Collection of data

Data collection was done through structured questionnaire which was filled by Principal investigator and Images evaluation was done by the Principal investigator and one Radiologist.

The questionnaire used had four parts that included, socio-demographics, seizure patterns(generalized, partial, absence and status epilepticus), risk factors for the seizures(that

included history of trauma, brain tumors, congenital anomalies and history of prior diagnosis of infections such as malaria, meningitis among others). The perinatal and birth information was also obtained, history of fever, family history of seizures, and other symptoms like cough, vomiting and the previous medical history. The fourth part included the MRI findings. Data was entered after reaching consensus of the MRI findings between the principle observer and the radiologist and in case of differing opinions a third radiologist was consulted.

2.11 Imaging and Evaluation

Patients in the study underwent brain MRI at the Radiology Department of MNH. Using 1.5 Tesla scanner (Phillips, Achiever, Best, Eindhoven, Netherlands), the MRI images were acquired in the standard T1 (pre and post contrast) T2, FLAIR, and DWI sequences.

The scans consist of 3mm slice axial, sagittal , coronal and coronal oblique T1-weighted (repetition time/echo time (TR/TE) of 400/8 MS, T1 Inversion Recovery images coronal and 2mm slice coronal oblique and T2-weighted (TR/TE of 3,000/120 MS) 3mm slice in axial, sagittal and coronal planes and 2mm coronal oblique plane. DW images and FLAIR in axial planes were also acquired. Sedation was used during the procedure depending on the patient cooperation.

Abnormal findings in the form of space occupying lesion, abnormal signal intensities, and altered normal anatomy were noted and analyzed further. The imaging was be performed by a qualified radiographer and the interpretation was done by the principal investigator, with consensus from one Radiologist. In case of disagreement between the two observers, a third opinion was sought from another radiologist. Data was entered after reaching consensus.

Patients with abnormal findings were directed to appropriate clinics for further management depending on their diagnosis and available services.

2.12 Reliability

Intra examiner consistency on imaging findings was based on imaging findings from 10% of randomly selected participants which was 6 patients. Measures of each finding were compared to and reported using Kappa statistics.

2.13 Data management and analysis

Data analysis was done using the Statistical Package for Social Sciences (SPSS) version 20. Statistical analysis between age, sex, history of seizure, imaging findings was done using cross tabulations and Chi-square test was used to compare proportions. P value of < 0.05 was considered statistically significant.

Data analysis examined relationship between different variables and MRI findings. The outcome was the MRI findings and the baseline independent variables included age, gender, and seizure type and associated risk factors that may cause seizures such as fever, and prematurity.

2.14 Ethical consideration

The Researcher introduced herself to the parent or guardian of a child and gave the explanation of the study then requested the parent/guardian to allow the child to participate in the study and assent was obtained from the parent/guardian. The Interview was conducted in a private room. The parents/guardians whom gave the consent their children were enrolled in the Study. The interpretation of the Images was done by the principal investigator and Radiologists. The patients' information's and images findings are confidential. Data was handled confidentially and stored in a secured place.

2.15 Ethical clearance

The proposal was presented to the department of Radiology, Muhimbili University of Health and Allied Sciences. Formal ethical approval was obtained from the Muhimbili university of Health and Allied Sciences Senate Research and Publications Committee. All ethical issues were adhered to as per Senate Research and Publications Committee criterion.

Permission to conduct the study at MNH Radiology department was obtained from MNH Authority.

2.16 Study limitation and Mitigation

The children are usually restless during imaging and therefore sedation was required in younger children.

MRI is an expensive and not readily available investigation therefore posed difficulties in sample size.

The study included children presenting at the radiology department only, this was a source of bias because not all children with seizures were included and hence the sample is not a true representative of the study population.

CHAPTER THREE

3.0 RESULTS

3.1 Sociodemographic factors among paediatric patients with seizure disorder undergoing brain MRI at MNH

Sixty two children were studied of which thirty nine (62.9%) and twenty three (37.1%) were male and female respectively. The age ranged from zero to seventeen years, with median and mean age of 6.81 and 5 years old respectively. The standard deviation was 4.8 as shown in table 1 below. The table also shows that under five years old were the most affected age 32(51.6%) followed by age group of 12-17 years old.

Table 1: The distribution of sociodemographic characteristics among paediatric patients with seizure disorder undergoing brain MRI at MNH. N=62

Demographic Characteristics		Number of patients	Percentage (%)
Sex	Male	39	62.9
	Female	22	37.1
	Total	**62**	**100**
Age group (years)	<5	32	51.6
	6-11	15	24.2
	12-17	15	24.2
	Total	**62**	**100**

3.2 The most common seizure patterns among paediatric patients with seizure disorder undergoing brain MRI at MNH

The results show that tonic clonic seizure was the commonest (82.3%) followed with partial seizure (14.5%), with status epilepticus seizure being the least (3.2%) as shown in the table 2 below. No cases of absence seizure seen.

Table 2: The seizure patterns among paediatric patients with seizure disorder undergoing brain MRI at MNH. N=62

Seizure pattern	Answer	Number of patients	Percentage (%)
Partial seizure	Yes	9	14.5
	No	53	85.5
	Total	**62**	**100**
Tonic clonic seizure	Yes	51	82.3
	No	11	17.7
	Total	**62**	**100**
Status epilepticus seizure	Yes	2	3.2
	No	60	96.8
	Total	**62**	**100**

3.2.1 Seizure pattern with age distribution

Tonic clonic seizure pattern was the commonest in the children aged 6 years and above. On the other hand, partial seizures and status epilepticus were common in the under 5 years though these observations were not statistically significant. (P> 0.05)

Table 3: The distribution of seizure pattern with age among paediatric patients with seizure disorder undergoing brain MRI at MNH. N=62

		Age group (years)				**P value (Pearson's X^2) at 95%CI**
		<5	**6-11**	**12-17**	**Total**	
Partial seizure	Yes	7 (21.9%)	2 (13.3%)	0 (0.0%)	9 (14.5%)	0.138
	No	25 (78.1%)	13 (86.7%)	15 (100.0%)	53 (85.5%)	
	Total	32 (100.0%)	15 (100.0%)	15 (100.0%)	62 (100.0%)	

3.3 The most common risk factors for seizures among paediatric patients with seizure disorder undergoing brain MRI at MNH

The results show that majority of the seizures were spontaneous 33(53.2%) followed by birth associated problem 11(17.7%), and meningitis and trauma had the similar frequency 4(6.5%) as shown in the table 3 below. Meningitis was the only causal factor with significant association with partial seizure pattern [r = 0.265, P = 0.038] as shown in the table 4 below.

Table 4: The distribution of the common risk factors for seizures among paediatric patients with seizure disorder undergoing brain MRI at MNH. N=62

Seizure causes		Number of patients	Percentage (%)
Meningitis	Yes	4	6.5
	No	58	93.5
	Total	**62**	**100**
Malaria	Yes	2	3.2
	No	60	96.8
	Total	**62**	**100**
Trauma	Yes	4	6.5
	No	58	93.5
	Total	**62**	**100**
Spontaneous	Yes	33	53.2
	No	29	46.8
	Total	**62**	**100**
Brain tumor	Yes	1	1.6
	No	61	98.4
	Total	**62**	**100**
Birth problems*	Yes	11	17.7
	No	51	82.3
	Total	**62**	**100**

***Birth asphyxia, birth trauma**

3.4 The MRI findings among paediatric patients with seizure disorder undergoing brain MRI at MNH

The study found that more than half of the patients had normal MRI 36(58.1%). followed with Infarct 5(8.1%), encephalomalacia 4(6.5%) and 3(4.8%) had other lesions (congenital anomalies, gliosis and hydrocephalus) as shown in details in table 5 below.

Table 5: The frequency of MRI findings among paediatric patients with seizure disorder undergoing brain MRI at MNH. N=62

MRI findings		Number of patients	Percentage (%)
Hydrocephalus	Yes	3	4.8
	No	59	95.2
	Total	**62**	**100**
Congenital anomalies	Yes	3	4.8
	No	59	95.2
	Total	**62**	**100**
Infarct	Yes	5	8.1
	No	57	91.9
	Total	**62**	**100**
Normal MRI	Yes	36	58.1
	No	26	41.9
	Total	**62**	**100**
Brain tumour	Yes	1	1.6
	No	61	98.4
	Total	**62**	**100**
Metastases	Yes	1	1.6
	No	61	98.4
	Total	**62**	**100**
Encephalomalacia	Yes	4	9.7
	No	56	90.3

	Total	**62**	**100**
Temporal lobe atrophy	Yes	1	1.6
	No	61	98.4
	Total	**62**	**100**
Neurocystcercosis	Yes	1	1.6
	No	61	98.4
	Total	**62**	**100**
White matter disorders	Yes	2	3.2
	No	60	96.8
	Total	**62**	**100**
Cerebral atrophy	Yes	2	3.2
	No	60	96.8
	Total	**62**	**100**
Gliosis	Yes	3	3.2
	No	60	96.8
	Total	62	100

Congenital anomalies: tuberous sclerosis, septal optic dysplasia, semilobar holoproencephaly.

Table 6: Percentage distribution of the MRI findings by pattern of seizure. (Partial seizures)

		Partial seizure			P value (Pearson's X^2) at 95%CI
		Total	**Yes**	**No**	
Hydrocephalus	Yes	3	0 (0.0%)	3 (5.7%)	0.464
	No	59	9 (100.0%)	50 (94.3%)	
	Total	62	9 (100.0%)	53 (100.0%)	
		total	yes	no	
Congenital anomalies	Yes	3	2 (22.2%)	1 (1.9%)	0.009
	No	59	7 (77.8%)	52 (98.1%)	
	Total	62	9 (100.0%)	53 (100.0%)	
Infarct	Yes	5	2 (22.2%)	3 (5.7%)	0.092
	No	57	7 (77.8%)	50 (94.3%)	
	Total	62	9 (100.0%)	53 (100.0%)	
Normal MRI	Yes	36	4 (44.4%)	32 (60.4%)	0.370
	No	26	5 (55.6%)	21 (39.6%)	
	Total	62	9 (100.0%)	53 (100.0%)	
Brain tumour	Yes	1	0 (0.0%)	1 (1.9%)	0.678
	No	61	9 (100.0%)	52 (98.1%)	
	Total	62	9 (100.0%)	53 (100.0%)	
Metastases	Yes	1	0 (0.0%)	1 (1.9%)	0.678
	No	61	9 (100.0%)	52 (98.1%)	
	Total	62	9 (100.0%)	53 (100.0%)	
encephalomalacia	Yes	4	1 (11.1%)	3(9.4%)	0.845
	No	58	10 (88.9%)	48 (90.6%)	
	Total	62	11 (100.0%)	51(100.0%)	
Temporal lobe atrophy	Yes	1	0 (0.0%)	1 (1.9%)	0.678
	No	61	9 (100.0%)	52 (98.1%)	
	Total	62	9 (100.0%)	53 (100.0%)	

	Yes	1	0 (0.0%)	1 (1.9%)	
Neurocycercosis	No	61	9 (100.0%)	52 (98.1%)	0.678
	Total	62	9 (100.0%)	53 (100.0%)	
	Yes	2	1 (11.1%)	1 (1.9%)	
White matter disorders	No	60	8 (88.9%)	52 (98.1%)	0.144
	Total	62	9 (100.0%)	53 (100.0%)	
	Yes	3	0 (0.0%)	3 (3.8%)	
Gliosis	No	59	9 (100.0%)	50 (96.2%)	0.554
	Total	62	9 (100.0%)	53 (100.0%)	

*Congenital anomalies: tuberous sclerosis, septal optic dysplasia, semilobar holoproencephaly.

This table shows the distribution of brain MRI findings with partial seizures, No relationship was found between the partial seizures and the MRI findings. This observation was not statistically significant ($P > 0.05$).

Table 7: **Percentage distribution of MRI findings of Tonic Clonic seizures**

		Tonic clonic seizure			P value (Pearson's X^2) at 95%CI
		Yes	**No**	**Total**	
Hydrocephalus	Yes	3 (5.9%)	0 (0.0%)	3 (4.8%)	0.410
	No	48 (94.1%)	11 (100.0%)	59 (95.2%)	
			11	**62**	
	Total	**51 (100.0%)**	**(100.0%)**	**(100.0%)**	
Congenital anomalies*	Yes	2 (3.9%)	1 (9.1%)	3 (4.8%)	0.469
	No	49 (96.1%)	10 (90.9%)	59 (95.2%)	
			11	**62**	
	Total	**51 (100.0%)**	**(100.0%)**	**(100.0%)**	
Infarct	Yes	3 (5.9%)	2 (18.2%)	5 (8.1%)	0.174
	No	48 (94.1%)	9 (81.8%)	57 (91.9%)	
			11	**62**	
	Total	**51 (100.0%)**	**(100.0%)**	**(100.0%)**	
Normal MRI	Yes	29 (56.9%)	7 (63.6%)	36 (58.1%)	0.680
	No	22 (43.1%)	4 (36.4%)	26 (41.9%)	
			11	**62**	
	Total	**51 (100.0%)**	**(100.0%)**	**(100.0%)**	
Brain tumour	Yes	1 (2.0%)	0 (0.0%)	1 (1.6%)	0.640
	No	50 (98.0%)	11 (100.0%)	61 (98.4%)	
			11	**62**	
	Total	**51 (100.0%)**	**(100.0%)**	**(100.0%)**	
Metastases	Yes	1 (2.0%)	0 (0.0%)	1 (1.6%)	0.640
	No	50 (98.0%)	11 (100.0%)	61 (98.4%)	
			11	**62**	
	Total	**51 (100.0%)**	**(100.0%)**	**(100.0%)**	
Encephalomalacia	Yes	3 (9.8%)	1 (9.1%)	4(9.7%)	0.942
	No	46 (90.2%)	12 (90.9%)	58 (90.3%)	

	Total	**49 (100.0%)**	**13 (100.0%)**	**62 (100.0%)**	
Temporal lobe epilepsy	Yes	1 (2.0%)	0 (0.0%)	1 (1.6%)	0.640
	No	50 (98.0%)	11 (100.0%)	61 (98.4%)	
	Total	**51 (100.0%)**	**11 (100.0%)**	**62 (100.0%)**	
Neurocystcercosis	Yes	1 (2.0%)	0 (0.0%)	1 (1.6%)	0.640
	No	50 (98.0%)	11 (100.0%)	61 (98.4%)	
	Total	**51 (100.0%)**	**11 (100.0%)**	**62 (100.0%)**	
White matter disorders	Yes	1 (2.0%)	1 (9.1%)	2 (3.2%)	0.225
	No	50 (98.0%)	10 (90.9%)	60 (96.8%)	
	Total	**51 (100.0%)**	**11 (100.0%)**	**62 (100.0%)**	
Gliosis	Yes	3 (3.9%)	0 (0.0%)	3(3.2%)	0.504
	No	48 (96.1%)	11 (100.0%)	59(96.8%)	
	Total	**51 (100.0%)**	**11 (100.0%)**	**62 (100.0%)**	

*Congenital anomalies: tuberous sclerosis, septal optic dysplasia, semilobar holoproencephaly.

This table shows percentage distribution of MRI findings by tonic clonic seizures.

More than half of the patients had tonic clonic seizures. On the other hand more than half of the patients had normal MRIs.

It was observed that, 56.9% of patients with tonic clonic seizures had normal MRI. No relationship between tonic clonic seizures and MRI findings observed and this observation was not statistically significant, ($P > 0.05$).

CHAPTER FOUR

4.0 DISCUSSION

The aim of this study was to investigate the patterns of MRI findings in children presenting with seizures at Muhimbili National Hospital, Dar es salaam, Tanzania and to characterise the patterns of identified lesions associated with seizures in these children.

All patients included in this cross sectional study underwent brain MR Imaging and the images were taken in coronal, sagittal and axial views. Contrast was used when needed, and images were taken in T1, T2, T1 contrasted, FLAIR and DW/ADC maps sequences. The sequences mentioned above constitute the seizure protocol here at MNH.

The study involved a total of 62 patients from age 0 to 17years. 32(51.6%) patients who were the majority of the patients participated in this study, were the under-five age group. The median age was 5 years. Similarly, a study done in Nepal by Adhikari et al, showed that most children with seizures were younger than 5 years of age. However a study by Ndubuisi et al showed that the group of age below 5years had the least amount of patients compared to the other age groups.(3,13)

Males had higher prevalence compared to females in this study (62.9%). This male dominance is observed in all age groups in this study. Similar findings of male dominance were reported in a study done by Ndubuisi et al, in Nigeria, Molla Mohammadi M, et al in Tehran and is also observed by Adhikari et al in Nepal.(3,13,23)

Generalised tonic clonic seizures were the commonest seizure pattern observed in 82 % of the patients. This pattern is also seen by Ndubuisi et al, Adhiakari and Molla et al. 15% of patients had partial seizures while 3% had status epilepticus seizure. There was no case of absence seizure pattern.(13,3,23).Tonic clonic seizure pattern was the commonest in the above 5 age group. On the other hand, partial seizures and status epilepticus were common in the age group of under 5 years.

Majority (87.5%) of the patients with fever had tonic clonic seizure pattern, P value=0.6. the remaining 12.5% had status epilepticus seizure, P value =0.112. similar findings were seen in a study by Adhikari et al(17). Fever was also common in the age group below 5 years.

The study shows that 53.2% of seizures were spontaneous with no specific risk factor observed. Meningitis, (6.5%) birth associated problems (birth asyphyxia, birth trauma) 17.7% and trauma 6.5% were the frequent risk factors of seizures. This finding is similar to other African studies where infections were common causes while Asian studies had infestation as the cause.(13,23)

Abnormal MRI findings were observed in 26(41.9%) children who participated in this study. This is higher than what has been reported by other studies (38) and lower than studies done by Ndubuisi et al and Adhikari et al. (16,29). This shows that most seizures are associated with a brain lesion although a significant number of normal studies was found.(3,13,25)

The most common findings were Infarct (8.1%), encephalomalacia (6.5%), congenital anomalies (4.8%), Gliosis and hydrocephalus (4.8%). There was no significant relationship of these patterns with seizure type observed.

Similar patterns were also seen in African study by Ndubuisi et al and a study by Molla Mohammadi M, in Tehran (36). These findings differ from a Nepalese study by Adhikari et al where neurocystcercosis was the commonest finding which was also shown to be associated with partial seizures.(17)

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Abnormal findings were found in 41.9% of patients who participated in this study. Although there is a significant number of normal MRI found, investigation of seizures in children is mandatory for proper management planning.

5.2 Recommendations

MRI is a safe and efficient imaging tool, I recommend all children presenting with seizures to be investigated thoroughly using this tool in order to plan for proper management.

I reckon for more studies regarding seizures in our society to be done to include bigger sample sizes and collaborations between different departments and a multicentre study.

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APPENDICES

Appendix I: Questionnaire

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES

SCHOOL OF MEDICINE - DEPARTMENT OF RADIOLOGY

P.O.BOX 65001 MUHIMBILI

DAR ES SALAAM

TANZANIA

Identity number …….

1. Demographic factors
   a. Age ……. (months)
   b. Sex ……. (M/F)
2. Seizure pattern
   a. Associated with fever 1. Yes 2. No
   b. Not associated with fever associated seizures 1. Yes 2. No
   c. Partial seizure 1. Yes 2. No
   d. Generalised seizure 1. Yes 2. No
   e. Tonic clonic seizure 1. Yes 2. No
   f. Status epilepticus seizure 1. Yes 2. No
   g. Absence seizure 1. Yes 2. No

3. What is the most common risk factors for seizure;

a. Fever

i. Meningitis 1. Yes 2. No

ii. Malaria 1. Yes 2. No

b. Trauma 1. Yes 2. No

c. Spontaneous 1. Yes 2. No

d. Brain tumour 1. Yes 2. No

e. Sickle cell disease 1. Yes 2. No

f. Birth associated problems 1. Yes 2. No

g. Primaturity 1. Yes 2. No

h. Infestation (neurocyscercosis) 1. Yes 2. No

4. What are the most common MRI findings associated with seizures:

a. Temporal lobe atrophy 1. Yes 2. No

b. Hippocampal sclerosis 1. Yes 2. No

c. Hydrocephalus 1. Yes 2. No

d. Limbic system inflammation 1. Yes 2. No

e. Cortical dysplasia 1. Yes 2. No

f. Congenital anomalies 1. Yes 2. No

g. Arteriovenous malformation 1. Yes 2. No

h. Meningeal inflammation 1. Yes 2. No

i. Cerebral contusions 1. Yes 2. No

j. Intra-cerebral hemorrhages 1. Yes 2. No

k. Germinal matrix hemorrhage 1. Yes 2. No

l. Extra-axial hemorrhages 1. Yes 2. No

m. Diffuse axonal injury 1. Yes 2. No

n. Gliosis 1. Yes 2. No

o. Infarct 1. Yes 2. No

p. Normal MRI 1. Yes 2. No

q. Brain tumour 1. Yes 2. No

r. Birth associated problems (eg. Hypoxic Ischemic encephalopathy)

1. Yes 2. No

Appendix II: Consent Form (English Version)

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES

DIRECTORATE OF RESEARCH AND PUBLICATIONS, MUHAS

ID-NO……

Consent to Participate in a Study

My name is Dr. Beatrice Ndossi; I am conducting study on MRI findings among children presenting with seizures referred for MRI at Radiology department, MNH.

Study Purpose

The study is conducted as partial fulfillment of the requirements of MMed. Radiology at

MUHAS. The study is also conducted to establish reference parameters which can be used for diagnosis and follow up in our department.

How to be involved

The parents who agree for their children to participate in this study will be required to sign the consent form, then interviewed after that.

Confidentiality

The information obtained from you will be confidential. No name will appear on any document of this study instead Identification numbers will be used.

Participation and right to Withdraw

Involvement in this study is voluntary. You can participate or refuse to participate from this study. Refusal to participate from this study will not interfere with your management.

Benefits

The information that you provide will help us to describe the MRI findings among children presenting with seizures. Thus the study outcomes will help to improve patients' management thus improve quality of life.

Contact Personally

If you ever have questions about this study, you should contact the Principal Investigator, Dr. Beatrice Ndossi, Muhimbili University of Health and Allied Sciences, P. O. Box 65001, Dar es Salaam. Tel. 0686 526560**.**

OR in case you have questions about your rights of participation in this study you may contact

Prof Said Aboud, Chairperson of the Senate Research and Publications Committee,

P. O. Box 65001 DSM. Telephone**:** +255 022 2152489

Dr. M. Balowa who is the supervisor of this study

Tel. 0788002506

Participant agrees ……..

I ……. have read the contents in this form. My questions have been answered. I am willing to participate in this study.

Signature of participant ……Date…….……

Signature of Researcher ……..Date…….

Appendix III: Consent Form (Swahili Version)

CHUO KIKUU CHA SAYANSI ZA AFYA MUHIMBILI

KURUGENZI YA TAFITI NA UCHAPISHAJI

FOMU YA RIDHAA

Namba ya utambulisho ---

Ridhaa ya kushiriki kwenye utafiti

Jina langu ni Dr. Beatrice Ndossi, nafanya utafiti wenye lengo la kuangalia majibu ya vipimo vya MRI kwa watoto wenye degedege wanaofanyiwa MRI ya kichwa kwenye idara ya vipimo vya mionzi katika Hopitali ya Taifa Muhimbili.

Madhumuni ya Utafiti huu ni pamoja na kutimiza sehemu ya matakwa ya shahada ya uzamili ya matibabu kitengo cha vipimo vya mionzi Chuo Kikuu cha Afya na Sayansi ya Tiba Muhimbili.

Jinsi ya kushiriki

Ukikubali mtoto kushiriki katika utafiti huu, utasailiwa alafu utatakiwa kujibu maswali kutoka kwenye dodoso lililoandaliwa alafu mtoto ataendelea na kipimo kama kawaida.

Usiri

Taarifa zote zitakazokusanywa kupitia dodoso hili zitakuwa ni siri. Jina lako halitatumika badala yake tutatumia namba ya utambulisho.

Uhuru wa kushiriki na haki ya kujitoa

Kushiriki kwenye utafiti huu ni hiari. Unaweza kushiriki au kukataa kushiriki na hii haitakuondolea haki ya kupata matibabu yako.

Nani wa kuwasiliana naye

Kama una maswali kuhusiana na utafiti huu, wasiliana na mtafiti mkuu, Dr. Beatrice Ndossi,

Chuo Kikuu cha Afya na Sayansi ya Tiba Muhimbili, S. L. P. 65001, Dar es Salaam. Simu

0686 526560. Prof Said Aboud**,** Mwenyekiti wa kamati ya Utafiti na Uchapishaji, S.L.P 65001,

Dar es Salaam. Simu +255 022 2152489 au msimamizi wa utafiti huu Dr. M. Balowa

Simu 0788 002506

Kama umekubali kushiriki weka sahihi

Mshiriki nimekubali …….....

Mimi..... nimesoma maelezo ya fomu hii nimeyaelewa na

nimekubali kushiriki katika utafiti huu.

Sahihi ya mshiriki…… Tarehe ya kutia sahihi…….....

Sahihi ya mtafiti…… Tarehe ya kutia sahihi…….