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RESEARCH ARTICLE

PROFILE OF HORIZONTAL COMITANT STRABISMUS AND OUTCOME OF TREATMENT MODALITIES AMONG PATIENTS ATTENDING STRABISMUS CLINIC AT MUHIMBILI NATIONAL HOSPITAL

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ABSTRACT

Background: Horizontal comitant strabismus is a misalignment of the eyes in which the magnitude of misalignment is the same in all directions of gaze. The global prevalence of horizontal comitant strabismus ranges between 2% to 4%. Untreated horizontal comitant strabismus has visual, social, psychological and mental impact on both children and adults that affect their daily lives. The goals for the treatments are to restore proper ocular alignment, improve visual acuity and restore binocular single vision. The common treatment modalities are spectacle, strabismus surgery and orthoptic exercises. At the strabismus clinic at Muhimbili National Hospital (MNH) several patients attended every week. However, the profile, outcomes of treatment and associated factors have not been studied, which is important for benchmarking and counseling process for practitioners and patients' choice of different treatment modalities. **Aim:** To determine the profile of horizontal comitant strabismus and outcome of treatmenmodalities among patients attending strabismus clinic at MNH. **Methodology:** A prospective cohort study conducted at MNH from May to December 2021. A total of 105 participants were recruited consecutively. An interviewer administered questionnaire was used to collect data on socio-demographic characteristics, medical history, and examination findings of comitant strabismus. Orthoptic assessment was repeated at 6 weeks post treatment. Measurement of post treatment ocular alignment, visual acuity and binocular single vision (stereopsis) were recorded and analyzed by SPSS version 23.0 **Results:** Majority (73.3%) of participants had esotropia, and among these,67.5% had accommodative esotropia. Patients who were treated with spectacles, strabismus surgery and orthoptic exercise (pencil push-up) were 76.2%, 20.9% and 2.9% respectively. Good ocular alignment was attained in 40.4% of patients with accommodative esotropia treated with spectacles, 70% of patients with congenital horizontal strabismus treated with strabismus surgery and 66.7% of patients with convergency insufficiency treated with orthoptic exercise. Small angle of deviation before spectacle treatment in patients with accommodative esotropia was associated with good outcome. **Conclusion:** Majority of patients attending strabismus clinic at MNH had horizontal comitant strabismus. Esotropia type of horizontal deviation was common and the overall outcome of treatment by different modalities was good. However, a small angle of deviation was associated with good ocular alignment in patients treated with spectacles. **Recommendation:** This study recommends early refraction and correction of accommodative esotropia because of observed good outcome. Patients with large angles should be counselled for strabismus surgery early after refractive correction and further studies to assess their treatment outcomes and determinants of outcome should be done.

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INTRODUCTION

Strabismus is a misalignment of the eye when looking straight ahead to an object. It is classifiedinto different ways based on direction of the eye deviation. Horizontal comitant strabismus is an inward (toward the nose) or outward (away from nose) misalignment of the eye in which the magnitude of misalignment is the same in all direction of gaze regardless of a fixating eye(1,2,3). Different modalities are used for treatment which aim to restore proper ocular alignment, improve visual acuity and restore binocular single. Untreated horizontal comitant strabismus has visual, social, psychological and mental impact to both children and adults that affect their daily lives. It is reported that the prevalence of strabismus is about 3% to 6% among pediatric and adult population globally (1). Horizontal comitant strabismus ranges between 2% to 4% (1,2,3).Tanzania is among the countries with high

prevalence of strabismus of 5.9%, while horizontal comitant strabismus accounts for 4% of the patients with strabismus (5).Strabismus treatment in Tanzania is mainly done at tertiary hospitals including MNH and others are CCBRT and Kilimanjaro Christian Medical Centre. The pathophysiology of horizontal comitant strabismus remain unknown, although there are postulated theories which state that it results from innervational imbalance in the vergence fusion centers located in the brainstem (4) Horizontal comitant strabismus interferes with normal binocular single vision and visual acuity of the affectedpatient. The mechanism of how binocular single vision is affected is explained as: when the eyes are properly aligned, visual information from each eye going to the brain are the same because both eyes fixate at the same object hence similar image from each eye will be presented to the brain, thereafter the brain will fuse the two similar images to form one image, and thus a single image will be seen by both eyes. When there is misalignment of eyes of greater than 10 prism dioptres, the brain will no longer be able to fuse the images coming from each eye because of greater images dissimilarities. The suppressed eye will become lazy (amblyopia) if it occurs below 8 years old. Amblyopia contributes markedly to childhood visual impairment because it reduces binocularity which can lead to greater risks of falls and injuries (6). But when it occurs above 8 years old it will cause visual disturbances such as diplopia, asthenopia and sometime confusion. Three treatment modalities are mainly used in strabismus, includes spectacles, strabismus surgeries and orthoptic exercises. Use of spectacles in the treatment of strabismus is employed in all types of horizontal comitant strabismus which are associated with refractive errors. However, Spectacles alone can be the definitive treatment to some types of horizontal comitant strabismus such as refractive accommodative esotropia. Strabismus surgeries are primarily done to congenital misalignments which are not associated with refractive error and for acquired forms which have significant deviation after refractive error correction. Furthermore, orthoptic exercise are done to the patients with convergency insufficiency in order to align the eyes which will lead to fusion improvement, pencil push up is the most initial exercise prescribed. The early appropriate time for measuring the outcome is usually six weeks post treatment of horizontal comitant strabismus. During this period, the eye becomes stable and the outcome of treatment modality can be measured and graded based on ocular alignment, binocular single vision status and visual acuity (4). It is important to know early the outcome of different treatment modalities because appropriate treatment measures can be taken for significant residual amount of ocular deviation which will lead to achievement of strabismus management goals. In most studies there is observed variation of outcome of different treatment modalities, good outcome is mainly reported on ocular alignment. Visual acuity and binocular single vision outcomes are reported in few studies of which results are contradicting some reporting good outcome while others reporting poor outcome (11,15,20,22,23,25,26). At Muhimbili National Hospital (MNH), there was no data which shows the outcome of treatment modalities used in patients with horizontal comitant strabismus. Knowledge about these outcomes will help in improving the quality of care in patients with horizontal comitant strabismus. Hence this study aimed to determine the profile of horizontal comitant strabismus and outcome of treatment modalities among patients attending the strabismus clinic at Muhimbili National Hospital**.**

Problem statement

In Tanzania the prevalence of strabismus is high approximately 5.9% while horizontal comitant strabismus is the commonest type with approximately 4% of the patients (5). Untreated horizontal comitant strabismus has visual, social, psychological and mental impact on both children and adults that affect their daily lives. In children, it contributes markedly to childhood visual impairment because of the risk of developing amblyopia but also reduced binocularity which can lead to greater risks of falls and injuries (6). Adult patients with strabismus may experience diplopia, impaired depth perception, asthenopia, difficulty in driving, social stigmatization, difficultywith marital relationships and other psychosocial problems such as cosmesis and lack of self- confidence (7). In our setting, at Muhimbili National hospital there is increasing number of new patients with strabismus every year since its initiation about 12 years ago, whereby at the start of clinic in 2010 there were 98 new patients attended which were keeping on increasing yearly reaching 256 new patients in year 2021.Inspite of increasing trend observed the outcome of different treatment modalities are not known.

Hence the aim of this study was to determine the profile of horizontal comitant strabismus and outcome of treatment modalities among patients attending strabismus clinic at Muhimbili National Hospital**.**

Rationale

This study's findings will be used to strengthen the management protocol for strabismus at Muhimbili National Hospital hence improvement of quality of care in managing horizontal comitant strabismus.

Research questions

- What is the proportion of patients with horizontal comitant strabismus amongpatients attending strabismus clinic?
- What are the types of horizontal comitant strabismus among patients attendingstrabismus clinic?
- What are the outcomes of treatment modalities in the different types of horizontal comitant strabismus among patients attending strabismus clinic?
- What are the factors affecting outcome of treatment modalities in the types ofhorizontal comitant strabismus among patients attending strabismus clinic?

Objectives

Broad objective: To determine the profile of horizontal comitant strabismus and outcome of treatment modalities among patients attending strabismus clinic at Muhimbili National Hospital.

Specific objectives

- To determine proportional of horizontal comitant strabismus among patients attendingstrabismus clinic.
- To determine the types of horizontal comitant strabismus among patients attendingstrabismus clinic
- To determine the outcome of treatment modalities in the different types of horizontal comitant strabismus among patients attending strabismus clinic.
- To determine the factors affecting outcome of treatment modalities of horizontalcomitant strabismus among patients attending strabismus clinic.

Conceptual Framework

Horizontal comitant strabismus is an abnormal alignment of eyes with equal magnitude of deviation in all positions of gaze. It has two major forms, esotropia and exotropia. Different treatment modalities are used in its management, and the outcome of treatment are measured based on alignment, visual acuity and binocular single vision (fusion and stereopsis). Social demographic and clinical characteristics can affect outcome of treatment modalities

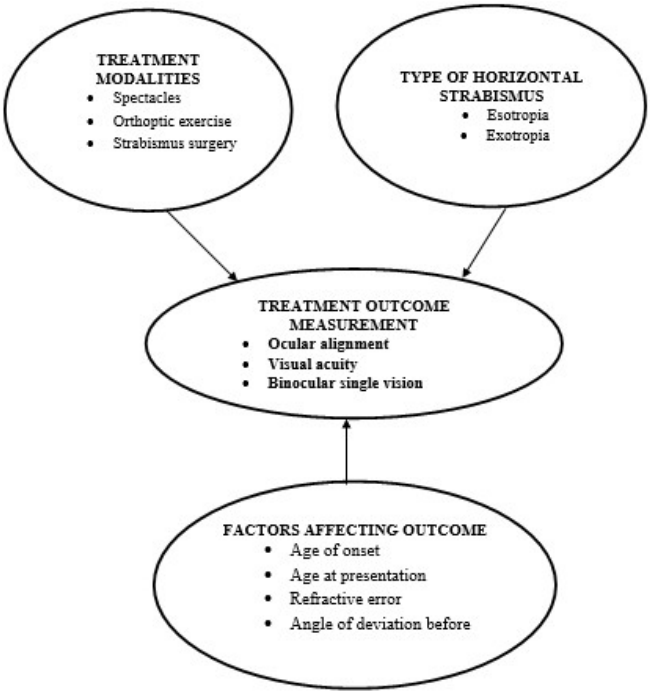

Figure 1. Conceptual framework on the profile of horizontal comitant strabismus and outcomeof treatment among patients attending strabismus clinic at MNH

LITERATURE REVIEW

The prevalence of strabismus is about 3% to 6% among pediatrics and adult population globally (1). Horizontal comitant strabismus is the most common type accounting for 2% to 4% percent of cases (2,3). In the study done in Pakistan 2017 by Paras A. et 87.4% of patients with strabismus had horizontal comitant strabismus (12) and in another study which was done in India 2005 by Rohit S et al number of patients with horizontal comitant strabismus were 78%(13). However, there is scarcity of data from developing countries

Types of horizontal comitant strabismus: Horizontal comitant strabismus is classified as exotropia and esotropia

Esotropia: Esotropia is characterized by the inward turning of one eye relative to the other. Commonest esodeviation types include congenital esotropia, accommodative esotropia and non- accommodative esotropia (2,9). Congenital esotropia, is an esotropia present within 6 months of life and is characterized by a large angle of >40PD, which can be associated with latent nystagmus, a cross fixation, a normal accommodative convergence to accommodative ratio, and age-appropriate refractive errors. The definitive treatment is strabismus surgery and correction of significant refractive error if any (11,14). Accommodative esotropia is an esotropia which occurs due to activation of accommodative reflex. The onset time is between 6 months and seven years, initially is intermittent but later become constant and its definitive treatment is spectacle while strabismus surgeryis indicated for residual significant esotropia (11). There are three types of accommodative esotropia, which are refractive accommodative esotropia, partial accommodative esotropia and non-accommodative esotropia. Refractive accommodative esotropia is also termed hypermetropic accommodative esotropia or full accommodative esotropia, associated with change of accommodation in a patient with hyperopia. It is usually associated with significant hypermetropia of +3.00 or more. The size of a deviation is the same at

distance and near fixation (normal AC/A ratio) and is typically smaller than congenital esotropia, usually measuring between 20 and 40 PD. It is fully corrected by full refractive error correction (spectacle) by 4 to 6weeks (2,14). Partial Accommodative esotropia, esotropia shows reduction in the angle of esotropia when wearing spectacles but significant residual deviation of more than 10 PD for distance and nearremain despite provision of full hyperopic correction. It has a normal AC/A ratio. The residualpart of esotropia is corrected by surgery (14). Non refractive esotropia is not associated with accommodation and is characterized by high accommodative convergence/ accommodation (AC/A) ratio, have an excessive convergence response for accommodation required to focus while wearing full cycloplegic correction, the deviation is large at near. Bifocals spectacle is the treatment of choice (14).

Prevalence of esotropia: In a study which was done in Singapore-Asia by Chia A, among patients with esotropia, accommodative esotropia was the leading type which accounted for 53%, followed by infantile type 23% (15). In Africa, in a study done in Nigeria by Olusanya et al among 240 patients with strabismus,infantile esotropia occurred in 12% and followed by accommodative esotropia 5.8% and acquired non-refractive esotropia 5.8% (16). In a hospital-based study done in Tanzania at CCBRT by Njambi Et al, which involved 220 patients,accommodative esotropia comprised more than 50% of esotropia followed with infantile esotropia (5).

Exotropia

Exotropia or manifest divergent strabismus is characterized by the outward turning of one eyerelative to another. The commonest exotropia subtypes are congenital (infantile) exotropia and intermittent exotropia. Intermittent exotropia includes basic intermittent exotropia, convergence insufficient and divergence excess (2,8). Congenital exotropia is the exotropia present within 6months of life. Usually, it has a large angleof more than 40 PD. The definitive treatment is Strabismus surgery (4). Intermittent exotropia is the exotropia that begins as a latent deviation and become manifest over time. Onset is between 2-4 years old. It has three types based upon the concept of fusion convergence and divergence. The types are Basic Intermittent exotropia, Convergence insufficiency, Divergence excess and treatment options include spectacle, strabismus surgery and orthoptic exercise (4,8). Basic Intermittent exotropia is a type of exotropia in which measured deviation at distance is within 10 prism dioptres of the near deviation. Patients with basic type deviation have normal AC/A ratio. It is treated by correction of refractive if any and strabismus surgery when there is poorfusion control (2). Divergence excess is present when the distance deviation is 10 prism dioptres greater than thenear deviation. Approximately 60% of patients with divergence excess had a high AC/A ratio (true divergence excess), and 40% had a normal AC/A ratio (simulated divergence excess). It is treated by correction of refractive error if any and strabismus surgery when there is poor fusion control (2). Convergence insufficiency is the exotropia in which the near deviation is greater than the distance deviation due to the inability to maintain convergence on objects as they approach from distance to near. Symptoms usually occur first during the teenage years and include asthenopia, difficult reading, blurred near Vision, and diplopia. It is treated by correction of refractive errors if any and orthoptic exercise (2).

Prevalence of exotropia: In the study done at Appalachia USA, which involved 255 patients with exotropia, Intermittentexotropia was more prevalent 47.7% followed convergence insufficiency (11.5%) while the least occurrence was congenital exotropia accounted for 1.7% (17). In Asia, a study done in China, which involved 269 school children, intermittent exotropia was the most prevalent of all subtypes of exotropia which accounts for 70.3%, whereas the convergence insufficiency part of intermittent exotropia was the rarest and accounted for 5.4% (18).While another study done in Kashmiri India, which involved 911 patients, intermittent exotropia was the leading and accounted for 58%, while the least occurrence was convergence insufficiency which were 6.88% (19).Furthermore a study done in Singapore National Eye Centre, 72% of children presented with exotropia, intermittent exotropia comprised 92% of all exotropia (15).

Outcome of treatment modalities in horizontal comitant strabismus: The main goals of different treatment modalities of horizontal comitant strabismus management are obtaining proper ocular alignment, restoration of binocular single vision and improvement of visual acuity (4). In Egypt a study done by Mohamed in 2018-2020 on the prevalence of strabismus and outcome of treatment modalities, strabismus surgery was the most treatment modalityused for managing horizontal comitant strabismus accounting for 42.6% followed by spectacle treatment 41.1% and orthoptic exercise 12.9% (20). In the study done in Dublin Ireland by Alan M et al, among the patients with accommodative esotropia post treatment with spectacle 39.8% attained good ocular alignment, while improvement of visual acuity occurred in 45.7% (23). Sabina Shrestha in Nepal reported in her study that patients with congenital horizontal strabismusabout, 77.5% had good ocular alignment post strabismus surgery after 4 weeks but with little improvement in stereopsis by 3% (21). Outcome of congenital strabismus was good ocular alignment of <10PD in 96% of patients but with littleimprovement of visual acuity in Cambodia in a study done by Soryoun Soeung. (22). In USA the study by Gallaway M et al in 2001 reported the outcome of treatment of convergence insufficiency treated with pencil pushup to be 58% which improved in near point of convergency and attained good ocular alignment (25).

Factors affecting outcome of treatment modalities in the types of horizontal comitantstrabismus: A systematic review done in India by Ramesh K et al on management of strabismus revealed that large angle of ocular deviation larger than 50PD was associated with poor ocular alignment post spectacle correction alone (26). In the study done in USA by Arnoldi K on outcome of partial accommodative esotropia showed that large angle of deviation of more than 50D was associated with poor ocular alignment outcome (27). Suchada K, in Thailand who studied the surgical outcome of horizontal comitant strabismus and factors affecting surgical success which involved 304 patients who underwent their first strabismus surgery for treatment of horizontal deviation. Age of the patient, angle of deviation before, pre surgery visual acuity, type of deviation was not associated with post-surgical treatment outcome (28).

METHODOLOGY

Study design: It was a prospective cohort study

Study duration: The study was conducted from May 2021 to December 2021.

Study area

The study was conducted at strabismus clinic at Muhimbili National Hospital (MNH), Dar es Salaam Tanzania. The strabismus clinic is a subsection of outpatient services provided by the ophthalmology department of MNH. The clinic offers tertiary paediatric and adult consultant services to a catchment population of more than 11 million in Dar es Salaam, Coast, Morogoro, Zanzibar and all children and adults referred from other regions Tanzania. The clinic is conducted once a week, every Wednesday, from 8.00 am to 5.00 pm. Around ten patients attended per week, and 40 children and adults per month are treated. Muhimbili National Hospital is situated in the middle of Dar es Salaam city in Tanzania. It is a tertiary hospital serving inpatients and outpatients from all over the country. It is also a teaching hospital for the Muhimbili University of Health and Allied Sciences. Muhimbili National Hospital is a government hospital conducting a specialized paediatric and adult eye care in Tanzania.

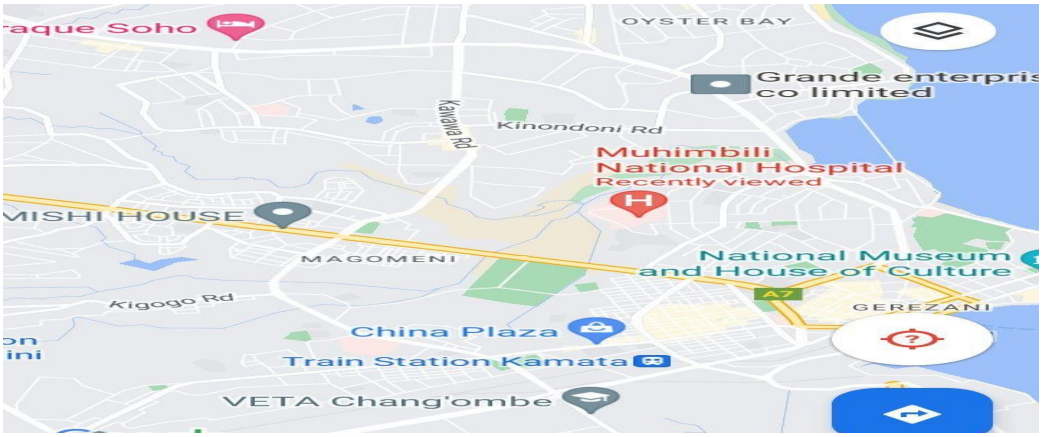

Figure 2. Location of MNH in Dar Es Salaam (Source: Google maps)

Target population: All new patients with manifest strabismus who attended the strabismus clinic at MNH

Study population: All new patients with horizontal comitant strabismus who attended strabismus clinic at MNH during the study period.

Inclusion criteria: All new patients aged 6 months to 35 years with horizontal comitant strabismus who attendedstrabismus clinic at MNH.

Exclusion Criteria: All new patients with horizontal comitant strabismus associated with neurological manifestation such as cerebral palsy, down syndrome and sensory strabismus due to preexistingocular disease such as cornea opacity, cataract, glaucoma, congenital optic hypoplasia, deep amblyopia, presence of nystagmus etc. Also new patients who were previously treated with any treatment modalities.

Sampling technique: Non probability Consecutive sampling was done: patients who met the inclusion criteria were recruited into the study.

Sample size: The sample size estimation was calculated by using the Leslie Kish formula below.

$$n = \frac{z2\,(100 - p)}{\varepsilon 2}$$

Where:

n = Minimum required sample size
z = percentage point of the normal distribution corresponding to the level of confidence
$\varepsilon 2$= Margin of error
p= expected proportion with the characteristic of interest
Using the prevalence of manifest strabismus of 5.9%, A study done at CCBRT (5). The marginal error of 5%
The sample size becomes

$$n = \frac{(1.96 \times 1.96) \times 5.9(100 - 5.9)}{5X5} = 86$$

Sample size =86.

Study variables: Independent variables were age, Sex, refractive errors, horizontal comitant strabismus types, treatment modalities (spectacles, orthoptic exercise, strabismus surgery). Dependent variables were outcome of treatment modalities which included visual acuity, angle of deviation, and binocular status (fusion and stereopsis) post treatment-the outcome was scored using a scale of 1-3 and interpreted as 1-good outcome, 2-fair outcome and 3- poor outcome

-Factors affecting treatment outcome were analyzed based on overall angle of deviation where by, an angle of deviation ≤15PD was considered as good outcome and an angle > 15 PD was considered as poor outcome.

Data collection tools: A researcher administered structured questionnaire was used to collect information on social demographics and clinical findings.

Data collection procedures: All new patients with Horizontal comitant strabismus presenting to strabismus clinic at MNH between May 2021 and December 2021 were informed about the study. Each individual filledinformed consent for adult patients. But for pediatric patients, the informed consent was filled by the parent or guardian (is available at appendix 6).

Data was collected by a researcher, including thorough history taking, physical examination, ocular examination, refraction and Orthoptic assessment. The following were series of examinations after history taking and systemic examination in which the baseline information was kept and repeated after 6 weeks.

Visual acuity measurement: All new patients were assessed their VA, monocular uncorrected visual acuity (UCVA), and best-corrected visual acuity (BCVA) were taken using age -appropriate vision chart testing. Fixation preference VA test was used for preverbal children in which teller acuity cards were used, and for verbal children and pre-school children Cardiff card, K pictures and Sheridan Gardner test were used. For school children and adults, Snellen chart was used while tumbling E was used for illiterate. Visual acuity was categorized based on WHO visual impairment guideline.

Anterior and posterior segment ocular examination: It was done using slit-lamp bio microscopy or Hein indirect ophthalmoscope.

Refraction: Cycloplegic refraction using cyclopentolate 1% eye drop was done to all patients withhorizontal comitant strabismus. For those patients found with significant refractive error were prescribed with spectacles. Significant refractive error was defined as hyperopia and myopia of above 3D, anisometropia of 1.5 D and above, any astigmatism type of refractive error. The guideline of spectacle prescription is found in appendix 6.

Orthoptic assessment: Was done chorological started with, Cornea light reflection test, which aimed to assess ocular alignment. Then cover/uncover test and alternative cover test for distance and near to assess manifest strabismus. Next, ocular motility examination was carried out with the help of a torchlight in all positions of gaze. Prism cover test for distance and near, with and without glasses in primary position. Krimsky test was for used uncooperative young children. Patient was considered to have small angle when had ≤30 PD, moderate angle of deviation when was between >30PD and ≤50 PD and large angle ≥50PD. Binocular single vision was evaluated for children above 3 years because the test needed cooperation from the patient. First, suppression was ruled out by Worth 4 Dot Test (W4DT) for near and distance. And second, those patients who had fusion (meaning no suppression) were checked for stereopsis by TNO method. Fine stereopsis was defined as ≤ 120 seconds of arc; moderate stereopsis was between 120-240 seconds of arc and Course stereopsis was ≥480 seconds of arc. Accommodation convergence accommodation ration (AC/A) ratio was measured clinically bycomparing the distance(6m) and near(33cm) ocular deviation, when there was a difference of more than 10PD, the gradient method was used to measure the ratio, +3D was lens used. Addition evaluation was done to the patients showed to have convergency insufficiency in which Near point of Convergency was measured with Royal Air Force (RAF) ruler, was documented normal when was between 6-10cm

Diagnosis: After history taking, physical examination and orthoptic examination patients were classified to either Esotropia or exotropia. For esotropia were further classified as congenital, accommodative or non-accommodative while for Exotropia were further classified as congenital, intermittent exotropia or convergence insufficiency.

Treatment: The type of treatment was based on type of strabismus and refractive status of the patients. The available treatment options were spectacle, strabismus surgery or orthoptic exercise. Patients were prescribed with one best treatment according to the presentation.

Spectacle: were prescribed to patients found to have significant refractive errors, protocol forrefraction found in appendix 6.

Surgical intervention-after pre anesthetic work out, the strabismus surgery was planned according to the angle of deviation following Marshall park's formula. The strabismus surgery in all subjects was done using limbal approach under general anaesthesia and was performedby same surgeon. The formular is available on appendix 6.

Orthoptic exercises were prescribed for the patients diagnosed with convergency insuffiency who had near point of convergence of more than 10cm, pencil push up was used. Patients were taught how to do the exercise alone at home, the exercise was to be done as much as possible for 30 minutes per single sitting twice a day for six weeks, then post treatment outcome was assessed.

Post treatment follow-up: The same procedure was repeated after 6 weeks post treatment and information was recorded in a structured questionnaire. The outcomes of interest were post treatment alignment, visual acuity and binocular single vision (fusion and stereopsis). Post treatment outcome for angle of deviation was defined as good if was ≤10 PD, Fair if was between >10 to ≤ 15 PD, and poor if was >15 PD. Visual acuity was defined as good outcome if was 6/6 - 6/18, Fair if was <6/18 - 6/60 and poor outcome if was <6/60- 3/60. Binocular single vision status was measured by TNO stereo test, good outcome considered when was 60 to ≤120 seconds of arc, fair outcome >120 to ≤480 seconds of arc and poor outcome when >480 seconds of arc.

Data management and analysis: The records of the patients with horizontal comitant strabismus were obtained in structured questionnaire, which included details of the patients at the first visit before intervention and details obtained on 6th week visit post intervention of horizontal comitant strabismus. Then data were transferred from the hand-written structured data forms into a data spreadsheetand analyzed with Statistical Package for Social Sciences software (SPSS) version 23.0. Each specific objective was analyzed whereby for objective number 1 which was "To determine proportional of horizontal comitant strabismus among patients attending strabismus clinic" summarization of data was done by calculating frequencies and percentages and the data was presented using pie chart.

For specific objective number 2 which was to "determine the types of horizontal comitant strabismus among patients attending strabismus clinic" summarization of data was done by calculating median, interquartile range, frequencies, and percentages of the variables of the interest and these data was presented using pie chart and tables. For objective number 3 which was "to determine the outcome of treatment modalities in the different types of horizontal comitant strabismus among patients attending strabismus clinic" descriptive analysis was done whereby cross tabulation was done for independent and dependent variables, the association of dependent variable versus independent variable was done by Chi-square test, and the P <0.05 was considered statistically significant.

For objective number 4 "determine the factors affecting outcome of treatment modalities of horizontal comitant strabismus among patients attending strabismus clinic" the association of social demographic Information and clinical information verses outcome of treatment modality(alignment) was analysed using Chi-square square test, and the P <0.05 was considered statistically significant.

Ethical considerations: Ethical clearance was sought from Muhimbili University of Health and Allied Sciences, Institution Review Board and permission to conduct the study was sought from MNH research committee. Written consent of all the patients was taken after fully explaining the procedure and purpose of the study to the patients. The Helsinki ethical declaration was obeyed whereby confidentiality was maintained throughout the study, and no names were used in the questionnaire, and participants were assured of the confidentiality of their information

RESULTS

There was slightly more female in the study. Most of the patients were between the age group of 5 to 10 years with median of 2 years and interquartile range (IQR) of 0.8- 3 years (Table1)

Table 1: Socio-demographic information of patients with horizontal comitant strabismus,N=105

Demographic information	Frequency	
	n	%
Sex		
Male	51	48.6
Female	**54**	**51.4**
Age (Years)		
≤ 1	3	2.9
1 – <5	40	38.1
5 – <10	**46**	**43.8**
10 – <18	10	9.5
> 18	6	5.7
Median (IQR)	2 (0.8, 3)	
Place of residence		
Within Dar-es -salaam	**86**	**81.9**
Other regions	19	18.1

Table 2. Clinical characteristics of patients with horizontal comitant strabismus, N=105

Clinical characteristic	Frequency	
	n	**%**
Age at onset of strabismus (Years)		
<6 months	25	23.8
6 months -<1	16	15.2
1 - < 5	**61**	**58.0**
5 - <10	1	1.0
10-<18	2	1.9
>18	0	0
Time lag to treatment (years)		
<1	6	5.7
1<5	**65**	**61.9**
5- <10	22	21.0
>10	12	11.4
Amblyopia before and after treatment		
Yes	**25**	**23.8**
No	80	76.1
Severity of amblyopia		
Mild (6/7.5->6/12)	12	48
Moderate (<6/12-6/36)	**13**	**52**
Refractive error		
Yes	**83**	**79**
No	22	21

Most of the patients had onset of strabismus at age of 1 to 5 years and most of patients had time lag to treatment of 1 to 5 years. Amblyopia was present in about aquarter of the patients. (Table 2)

Hyperopia was the most common refractive error in the study.(Figure 4)

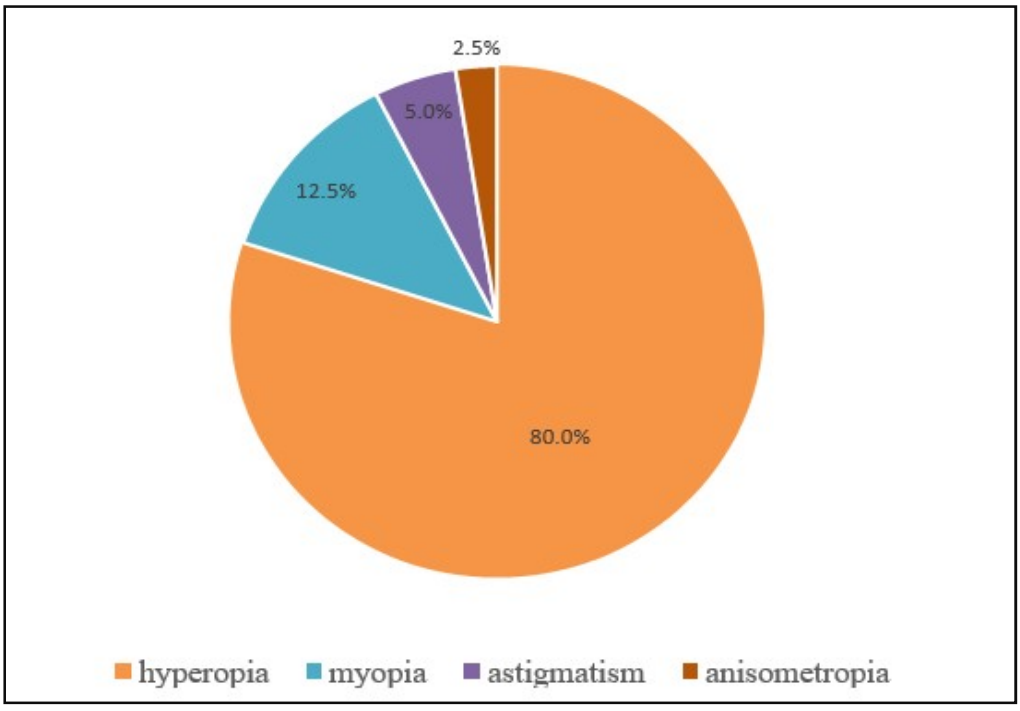

Figure 4. Refractive errors in patients with horizontal comitant strabismus

Majority of the patients had horizontal comitant strabismus 96%. (Figure 5)

Table 3. Distribution of patients with horizontal comitant strabismus, N=105

Frequency				Frequency	
	n	**%**		**n**	**%**
ESOTROPIA	**77**	**73.3**	EXOTROPIA	**28**	**26.7**
Congenitalesotropia	**25**	**32.5**	**Congenital/Infantile exotropia**	4	14.3
Accommodative	**52**	**67.5**	**Intermittent**	**21**	**75.0**
Refractive accommodativeesotropia	8	15.3	-Basic type	**19**	**90.5**
Partial accommodativeesotropia	**44**	**84.6**	-True divergence excess	2	9.5
			Convergence insufficiency	**3**	**10.7**

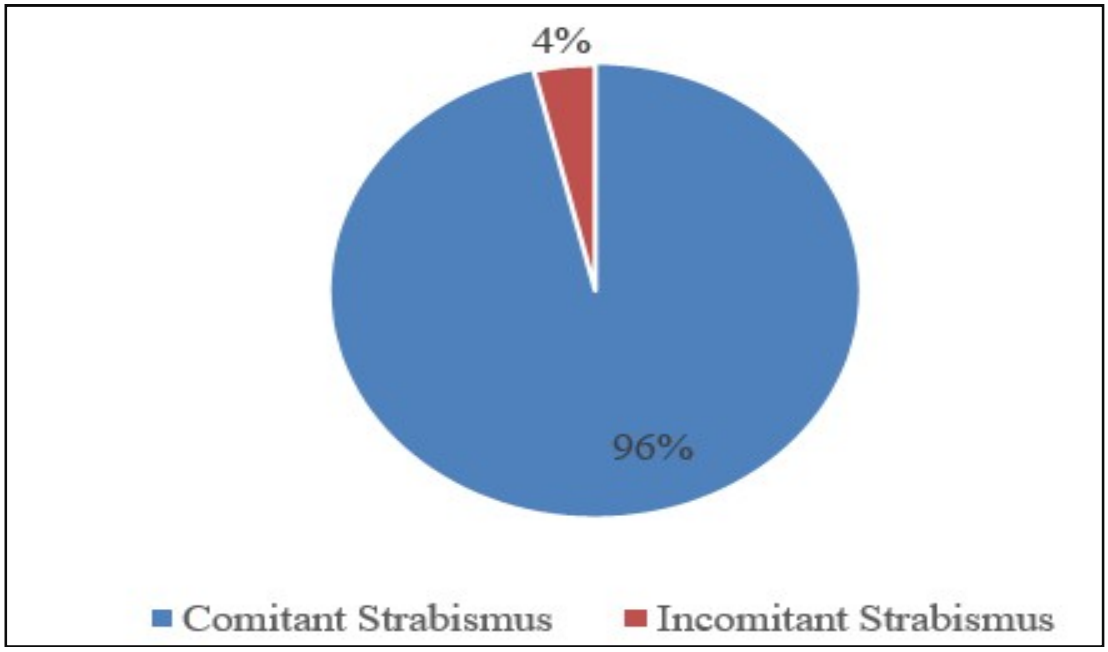

Figure 5. Proportion of patients with horizontal strabismus

The most common form of horizontal comitant strabismus was esotropia, whereby accommodative esotropia was the leading form. (Table 3)

Table 4. Treatment modalities used in patients with horizontal comitant strabismus,N=105

Type of treatment	Frequency	
	n	%
Spectacles	**80**	**76.2**
Strabismus surgery	**22**	**20.9**
Orthoptic exercise (pencil push up)	**3**	**2.9**

Spectacles were the most treatment modality used. (Table 4)

Table 5. Outcome of ocular alignment in different treatment modalities of horizontal comitant strabismus, N= 105

Type of treatment	Type of horizontal comitant strabismus	Angle of deviation (PD) Before treatment		Angle of deviation (PD) after treatment					
				Good*		Fair*		Poor*	
			n	n	%	n	%	n	%
Spectacle	Congenital Strabismus* (With refractive Error)	<30	0	**0**	**0**	0	0	0	0
		31-50	8	1	12.5	1	12.5	6	75.0
		>51	1	0	0	0	0	1	100
		Total	**9**	1	12.5	1	12.5	**7**	**75.5**
	Accommodative Esotropia	<30	24	16	66.7	1	4.2	7	29.1
		31-50	28	5	17.9	3	10.7	20	71.4
		Total	**52**	**21**	**40.4**	**4**	**7.7**	27	51.9
	Intermittent exotropia	<30	8	1	12.5	3	37.5	4	50.0
		31-50	9	1	11.1	0	0	8	88.9
		>51	2	0	0	0	0	2	100
		Total	**19**	**2**	**10.5**	**3**	**15.8**	**14**	**73.7**
Strabismus surgery	Congenital strabismus*	31-50	3	2	66.7	1	33.3	0	0
		>51	17	12	70.6	5	29.4	0	0
		Total	**20**	**14**	**70.0**	**6**	**30.0**	**0**	**0**
	Intermittent exotropia	31-50	1	0	0	1	100	0	0
		>51	1	0	0	1	100	0	0
		Total	**2**	**0**	**0**	**2**	**100**	**0**	**0**
Orthoptic exercise (Pencil push up)	Convergence insufficiency	<30	3	2	**66.7**	1	33.3		0

*Good-angle of deviation <10 PD *Fair-angle of deviation-10 – 15PD *Poor- angle of deviation >15 PD

***Congenital strabismus- congenital esotropia and congenital exotropia:** Among patients with accommodative esotropia treated with spectacles most of them achieved good ocular alignment post treatment. Most patients with congenital esotropia and

congenital exotropia treated with strabismus surgery achieved good ocular alignment post treatment. Great number of patients with convergence insufficiency treated with orthoptic exercise achieved good ocular alignment. (Table 5)

Table 6.Visual outcome of deviating eye in patients treated with different treatment modalities on horizontal comitant strabismus, N=105

Type of treatment	Type of horizontal comitant strabismus	Visual acuity (VA) Before treatment		Visual outcome after treatment					
				Good*		Fair*		Poor*	
			n	n	%	n	%	n	%
Spectacle	Congenital/ infantile	6/6-<6/18	6	6	100.0	0	0	0	0
	Strabismus*	6/18-<6/60	3	1	33.3	2	66.7	0	0
	Accommodative	6/6-<6/18	47	47	100.0	0	0	0	0
	esotropia	6/18-<6/60	4	**3**	**75.0**	1	25	0	0
		6/60-<3/60	1	0	1	100.0	0	0	0
	Intermittent exotropia	6/6-<6/18	17	17	100.0	0	0	0	0
		6/18-<6/60	2	**1**	**50.0**	1	50.0	0	0
Strabismus surgery	Congenital/infantile Strabismus*	6/6-<6/18	15	15	100.0	0	0	0	0
		6/18-<6/60	4	0	0	**4**	**100.0**	0	0
		6/60-<3/60	1	0	0	0	0	1	100.0
	Intermittent exotropia	6/6-<6/18	2	2	100.0	0	0	0	0
Orthoptic exercise	Convergence insufficiency	6/6-<6/18	3	**3**	**100.0**	0	0	0	0

*Good VA-6/6-<6/18
*Fair (Moderate Visual impairment)-6/18-<6/60
*Poor (severe Visual impairment)- 6/60-<3/60

***Congenital/infantile strabismus- congenital esotropia and congenital/infantile exotropia:** Majority of the patients with accommodative esotropia who had fair VA attained good VA after spectacle treatment. Most of the patients with congenital esotropia and exotropia treated with extraocular muscle surgery showed no improvement of VA. (Table 6)

Table 7. Outcome of binocular single vision (fusion) by Worth Four Dot Test in patients treated with different treatment modalities for horizontal comitant strabismus, N=90

Types of treatment	Type of horizontal comitant strabismus	Fusion status before treatment		Fusion status after treatment			
				Fusion		Suppression	
			n	n	%	n	%
Spectacle	Congenital	Fusion	0	0	0	0	0
	strabismus	suppression	7	0	0	7	100.0
	Accommodative	Fusion	4	4	100.0	0	0
	esotropia	suppression	46	**19**	**41.3**	27	58.7
	Intermittent	Fusion	1	0	0	1	100.0
	exotropia	Suppression	15	4	26.7	11	73.3
Strabismus	Congenital	Fusion	0	0	0	0	0
surgery	strabismus	Suppression	**12**	0	0	**12**	**100.0**
	Intermittent	Fusion	0	0	0	0	0
	exotropia	Suppression	2	2	100.0	0	0
Orthoptic	Convergence	Fusion	2	**2**	**100.0**	**0**	**0**
exercise	insufficiency	suppression	**1**	**0**	**0**	**1**	**100.0**

*Fusion-see 4 dots during the test (2 red,2 green) at near or at distance
*Suppression-see either 3 green dots or 2 red dots at near or at distance

Patients with accommodative esotropia who presented with suppression, significant numbers regain fusion after spectacle treatment while none of the patients with congenital strabismus treated with strabismus surgery regain fusion post-surgery. (Table 7)

Table 8: Outcome of binocular single vision (stereopsis) in patient treated with different treatment modalities of horizontal comitant strabismus, N=90

Types of treatment	Type of horizontal comitant strabismus	Stereopsis (in seconds of arc) Before treatment		Stereopsis (in seconds of arc) after treatment					
				Good*		Fair*		Poor*	
			n	n	%	n	%	n	%
		<120	0	0	0	0	0	0	0
Spectacle	Congenital	120-480	0	0	0	0	0	0	0
	strabismus	>480	**7**	**0**	**0**	**0**	**0**	**7**	**100.0**
	Accommodative	<120	0	0	0	0	0	0	0
	esotropia	120-480	5	3	60	2	40	0	0
		>480	**44**	10	22.7	6	13.6	**28**	**63.6**
	Intermittent	<120	0	0	0	0	0	0	0
	exotropia	120-480	0	0	0	0	0	0	0
		>480	**16**	**2**	12.5	2	12.5	**12**	75
Strabismus	Congenital	<120	0	0	0	0	0	0	0
Surgery	strabismus	120-480	0	0	0	0	0	0	0
		>480	**12**	**0**	**0**	**0**	**0**	**12**	**100.0**
	Intermittent	<120	0	0	0	0	0	0	0
	exotropia	120-480	0	0	0	0	0	0	0
		>480	2	0	0	1	50.0	1	50.0
Orthoptic	Convergence	<120	0	0	0	0	0	0	0
Exercise	insufficiency	120-480	1	1	100.0	0	0	0	0
		>480	2	1	50.0	0	0	1	50.0
		Total	3	2	66.7	0	0	1	33.3

*Good -15- <120 secs of Arc; *Fair 120-480 secs of Arc ; *Poor ->480 secs of Arc

Patients with accommodative esotropia and congenital strabismus treated with spectacle had poor stereopsis. (Table 8)

Table 9: Overall ocular alignment outcome in different treatment modalities of horizontal comitant strabismus, N=105

Type of treatment	Angle of deviation after treatment			
	Good outcome		Poor outcome	
	n	%	n	%
Spectacle	**37**	**43.0**	43	**53.8**
Strabismus surgery	**16**	**72.7**	6	**27.3**
Orthoptic exercise	**2**	**66.7**	1	**33.3**

*Good outcome - Angle of deviation ≤15 PD *Poor outcome -Angle of deviation >15PD

Majority of patients treated with extraocular muscle surgery had good ocular outcome (Table 9)

Table 10: Relationship between social demographic, clinical characteristic and outcome of horizontal comitant strabismus treated with spectacle.

Variable	Treatment outcome				P-value
	Good*		Poor*		
	n	%	n	%	
Sex					
Male	19	44.2	24	35.8	0.43
Female	18	48.6	19	51.4	
Age of the patients					
<10	35	47.3	39	52.7	0.64
10-18	1	25.0	3	75.0	
>18	1	50.0	1	50.0	
Time lag to treatment(years)					
0-<5	30	46.9	34	53.1	0.921
5-<10	5	41.7	7	58.3	
≥10	2	50	2	50	
Amblyopia					
Yes	8	53.3	7	46.7	0.372
No	29	44.6	36	55.4	
Angle of deviation before treatment					
<30 PD	25	69.4	11	30.6	**0.001**
31-50 PD	12	29.3	**29**	**70.7**	
>50 PD	1	25.0	2	75.0	

Good*-angle of deviation ≤15 PD; Poor*-angle of deviation >15 PD

There was an observed difference in overall treatment outcome in patients treated with spectacles in which patients presented with small angle of deviation were likely to get good outcome post treatment (Table 10)

Table 11: Univariate analysis showing association between social demographic, clinical characteristics and outcome of spectacle treatment in horizontal comitant strabismus

Variable	Crude Risk Ratio	95% CI	P-value
Sex			
Male	1.944	0.53-7.1	0.313
Female	ref	-	
Amblyopia			
Yes	1.982	0.61-7.3	0.32
No	ref	-	
Angle of deviation before treatment			
<30 PD	1.641	0.9-2.4	**0.02**
31-50PD	1.232	0.6-2.6	
>50PD	ref	-	

There was true association between patients presented with small angle of deviation and good outcome post spectacle treatment confirmed by univariate analysis. (Table 11)

Table 12: Relationship between social demographic, clinical characteristics and outcome of strabismus surgery in horizontal comitant strabismus

Variable	Treatment outcome				P-value
	Good		Poor		
	n	%	n	%	
Sex					
Male	4	33.3	8	66.7	0.11
Female	4	40	6	60	
Age (years)					
<10	0	0	2	100	0.43
10-<18	0	0	7	100	
≥18	1	16.7	5	83.3	
Time lag to treatment(years)					
0-<5	1	11.1	8	88.9	0.33
5-10	1	16.7	5	83.3	
≥10	3	18.2	4	81.8	
Refractive status					
Yes	5	71.4	2	28.6	0.65
No	11	73.3	4	26.7	
Amblyopia					
Yes	8	72.7	3	27.3	0.26
No	8	72.7	3	27.3	
Angle of deviation before treatment					
31-50 PD	3	75.0	1	25.0	0.70
>50 PD	13	72.2	5	27.8	

Good*-angle of deviation ≤15 PD; Poor*-angle of deviation >15 PD

There was a difference in overall treatment outcome in patients treated by extraocular muscle surgery for different social demographic and clinical characteristics groups which were statistically not significant. (Table 12)

DISCUSSION

Untreated horizontal comitant strabismus has visual, social psychological and mental impacts to both children and adults that affects their daily life, hence early recognition and treatment is important. In this study horizontal comitant strabismus was the leading form of strabismus, accounting for 96% among patients with manifest strabismus. This finding is in line with a previous study done in Pakistan 2017 by Paras A. et al where horizontal comitant strabismus was 87.4% of all patients with strabismus (12).

However, these findings are higher compared to the study which was done in India 2005 by Rohit S et al where patients with horizontal comitant strabismus were 78% (13). The observed difference may be due to sample size where our study recruited 105 patients compared to a large sample (1950) in the other study. In this study Esotropia was the commonest form of horizontal comitant strabismus accounting for 73.3% which is similar to other studies that were done in CCBRT in Tanzania by Njambi et al in 2014 and in Kashmir India by Rimsha S. et al in 2018 who reported 63.3% and 59.9 % respectively (5,6). In contrary to the study done by Chia et al in Singapore, the commonest form of horizontal comitant strabismus was exotropia 72% (19). It is known that hyperopia stimulates accommodation whereas myopia relaxes accommodation. In our study majority had hyperopia, hence esotropia while participants in the other study were commonly myopic. Among patients with exotropia, three quarters (75%) of patients had intermittent exotropia. This means that majority of participants with exotropia presented before conversion to constant exotropia. This is the critical period of which when treatment is done in children under eight years, amblyopia can be prevented

and hence good treatment outcome. Similar finding was observed in the study done in Egypt, by Rehab A et al who reported 86.7% of patients had intermittent exotropia (24).

Treatment of horizontal comitant strabismus aims at improving ocular alignment, visual acuity and binocular single vision. In this study majority of patients 76.2% were treated with spectacles, followed by strabismus surgery 20.9% and orthoptic exercises in 2.9% patients. In contrary to this study, Mohamed E in Egypt reported the commonest treatment modality to be strabismus surgery 42.6% followed by spectacles 41.1% and orthoptic exercises 12.9% (20). This difference can be attributed by the fact that majority of patients in our study had accommodative esotropia in which the first treatment option was spectacles. Good ocular alignment and visual acuity outcome was achieved in 40.4% and 75% of patients with accommodative esotropia treated with spectacles respectively, thus early refraction and correction of accommodative esotropia is recommended because of observed good outcome in patients with small angle of deviation and for the patients with large angles should be counselled for strabismus surgery early after refractive error correction. Similar findings have been found in the study done in Dublin Ireland by Alan M et al, patients who achieved good alignment were 39.8%, while improvement of visual acuity occurred in 45.7% (23). Findings from this study showed that patients with congenital horizontal strabismus treated with strabismus surgery had poor outcome in term of visual acuity and binocular single vision this suggest that most patients came for treatment after a long duration of time has passed since the onset of strabismus hence present with severe impairment of vision and stereopsis thus a longer period of time may be need for some recovery. Findings from this study show that the angle of deviation before treatment is the only factor affecting the outcome of treatment in patients treated with spectacles where a small angle of deviation <30 PD was associated with good outcome compared to large angles, similar findings reported in India and USA by Ramesh K et al, and Arnold et al. (26,27).
Moreover this study showed that 23.8% of patients presented with amblyopia of which 2(8%) were below eight years and received spectacle treatment with no improvement after six weeks and occlusion of the better eye was done thereafter. Hence parents should be insisted to seek eye health care as soon as they notice strabismus in their children for early treatment of amblyopia.
The results of this study showed that, strabismus surgery treatment to the patients with congenital strabismus results into good ocular alignment in 70% of patients, Similar findings were observed in studies done in Nepal and Cambodia by Sabina Shrestha and Soryoun Soeung who reported 77.5% and 96% of patients respectively (21,22)

LIMITATION OF THE STUDY

It was difficult to assess adherence to treatment to those patients treated with spectacle andorthoptic exercises when they were away from Hospital.

MITIGATION: Proper counselling of the parents of children and adult patients who received spectacle treatment was done at the time of spectacle prescription to improve adherence.

CONCLUSION

The proportion of patients with horizontal comitant strabismus in patients attending the strabismus clinic at MNH was high where esotropia was more common than exotropia. Majority of the patients treated with strabismus surgery, spectacle and orthoptic exercises had good outcome. However, a small angle of deviation was associated with good ocular alignment in patients treated with spectacles.

RECOMMENDATION

Early refraction should be emphases in patients with accommodative esotropia because of the observed good outcome.
Patients with large angles should be counselled for strabismus surgery early after refractive correction and further studies should be conducted to assess the treatment and determinants outcome.

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