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Institution at your home: Treat amblyopia

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Abstract; *Amblyopia is decreased vision consequent to abnormal visual experience like strabismus, stimulus deprivation or anisometropia leading to physiological alterations in visual cortex. In infants and children it has been successfully treated by occlusion. But, in adults it is still regarded has untreatable. Our aim is to study the effects of perceptual learning in treating amblyopia through home based spectacle mounted synoptophore (SMS).* ***Methods:*** *Spectacle based synoptophore was designed with locally available "bio-scope" toys mounted on a trial frame, fitted with LED lights for alternate flashing and sound producing chip. 10 amblyopic patients aged from 10- 40 years were given SMS with sound chip for use at home for 4 weeks and results were compared with 10 amblyopic patients exercising on similar miniature SMS not fitted with sound chip.* ***Outcome measures:*** *Compliance with treatment, Performance ratio.* ***Results:*** *Compliance ratio excellent in both groups. Performance ratio comparable in both groups with slightly better performance in Group A.* ***Conclusion:*** *SMS can improve the visual outcome in amblyopes through perceptual learning using contextual senses like sound. This can be useful for treating amblyopia in adults.*

Keywords: *Amblyopia, Perceptual learning, MSMS, Contextual senses.*

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I. Introduction

Amblyopia (Greek. Amblyos: blunt; opia: vision) is the most frequent cause of uniocular visual defect in children, involving 3% of general population. Levi et al[1] has defined amblyopia as a developmental disorder that results in physiological alterations in visual cortex and impairs form vision. Consequences of amblyopia are expressed as decrease in visual acuity(VA), reduction in contrast-sensitivity function and Vernier acuity as well as spatial distortion[2] and impaired contour detection[3] in an otherwise healthy eye. These are thought to result from abnormal operation of neuronal networking in primary visual cortex, particularly of orientation-selective neurons and their interactions[4]. Traditional amblyopia treatment of occlusion therapy or atropine penalisation, successfully treats amblyopia in infants and children. But, this treatment is considered ineffective for adults and children who fall outside the period of cortical plasticity.

Levi and Li in 2008 have clearly shown that adults with amblyopia can improve following perceptual learning[5]. Perceptual Learning has been defined as an evolution in the discernment of a stimulus array after repetitive exposure or practice with this array[6]. In Perceptual learning, a single visual percept is given to both eyes simultaneously or under monocular viewing conditions. The perceptual learning procedures train the abnormal neuronal networking by efficient stimulation and effectively promoting their spatial interactions. The concept of perceptual learning has emerged as a new modality of treatment for amblyopia in adults and various studies has shown promising results.

Even though perceptual learning has shown promising outcomes, various modalities for perceptual learning tasks used in studies are costly, institutional based and have exhaustive duration of training. We have tried to search an alternative to traditional amblyopia treatment through use of modified spectacle-mounted-synoptophore attached with music chip as a method of perceptual learning with binocular therapy which is home based and cost-effective also.

II. Materials & Method

Procedure:
20 amblyopic patients of 10-40 yr age were enrolled in this study.

Inclusion Criteria:
- Patients diagnosed with amblyopia
- Age: 10-40 years
- Gender- both

Excluson Criteria:
- Patients with diabetes or on anti-diabetics.
- Patients not willing for exercise or follow up.
- Patients using drugs e.g. ATT, Chloroquine that can cause vision loss without any fundus changes.

Miniature spectacle mounted synoptophore was made with locally available "bio-scope" toys and a trial frame. It was fitted with LED light for alternate flashing and sound producing chip. Group A included 10 amblyopic patients who were given MSMS with sound chip for exercise at home, and Group B included 10 amblyopes who were given this MSMS without sound producing chip for 10 minute daily exercise upto 4 weeks.

Brief description of spectacle mounted synoptophore (SMS) :
SMS is designed and assembled from locally available low cost components (Illustrations 1-6):
1) Trial Frame: Adjustable to angle of deviation in squint cases
2) Small binocular whose inner wall is covered with nonglossy sticking paper
3) LED bulb and switches
4) Synoptophore slides cut according to the size and shape of binocular tube

Assembly:
a) A trial frame was fitted with two eye-pieces made from small plastic conical toys/ binoculars with convex lenses (available in village fare to see different pictures viz.bioscope). Eye piece were movable according to the angle of deviation.
b) Pictures were made from synoptophore slides.
c) LED lights were further reinforced with the eye pieces.
d) Sound producing music chip was also fitted with the eye pieces. Use of sound with visual stimulus acts as a perceptual task in patients.
e) This is an eye wear or spectacle to improve vergence. Alternate stimulation can be done in amblyopia (lazy eyes).

Clinical vision tests:
In this study ETDRS chart was used to measure visual acuity after refractive error correction.

Salient Features of the innovation:
Lazy eyes are common in children which if detected and treated early can give good visual outcome. Besides occlusion, different orthoptic exercises on synoptophore requireinstitutional approach. This is time consuming and not accessible/ available everywhere. Simple spectacle designed with very low cost materials will help the amblyopic patients to exercise at home. Convergence deficiency or excess is very common among prolonged computer users. This simple device can also improve vergence faculty with daily 10 minutes exercise. Effects of Perceptual learning were quantified by comparing performance before and after training and expressed as PPR or Post: Pre Ratio.
PPR=1 ⟹ No improvement
PPR>1 ⟹ Improvement present
PPR<1 ⟹ Deterioration

III. Results

Table 1 and Graph 1

Age group	10-20 years	20-30 years	30-40 years
No. of participants	08	07	05

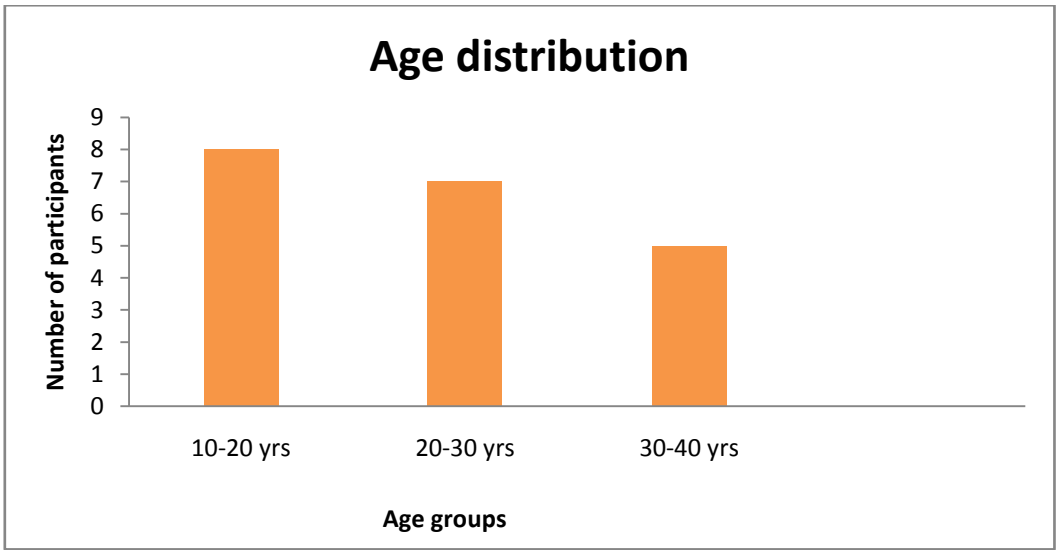


Table 2 and Graph 2

GENDER	NUMBER	%
MALE	12	60
FEMALE	8	40

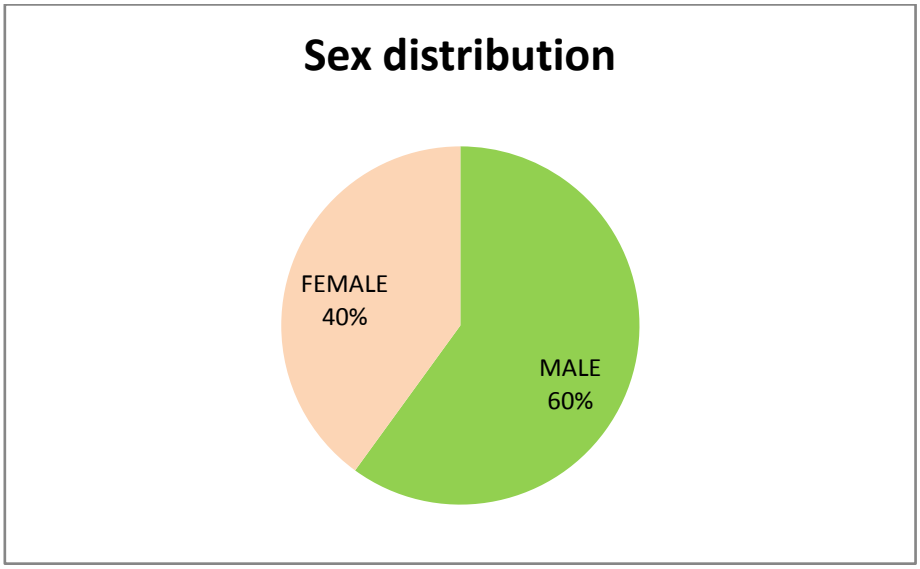


Table 3 and Graph 3

Laterality of amblyopia	GROUP A	%	GROUP B	%
Uniocular	7	70	8	80
Binocular	3	30	2	20

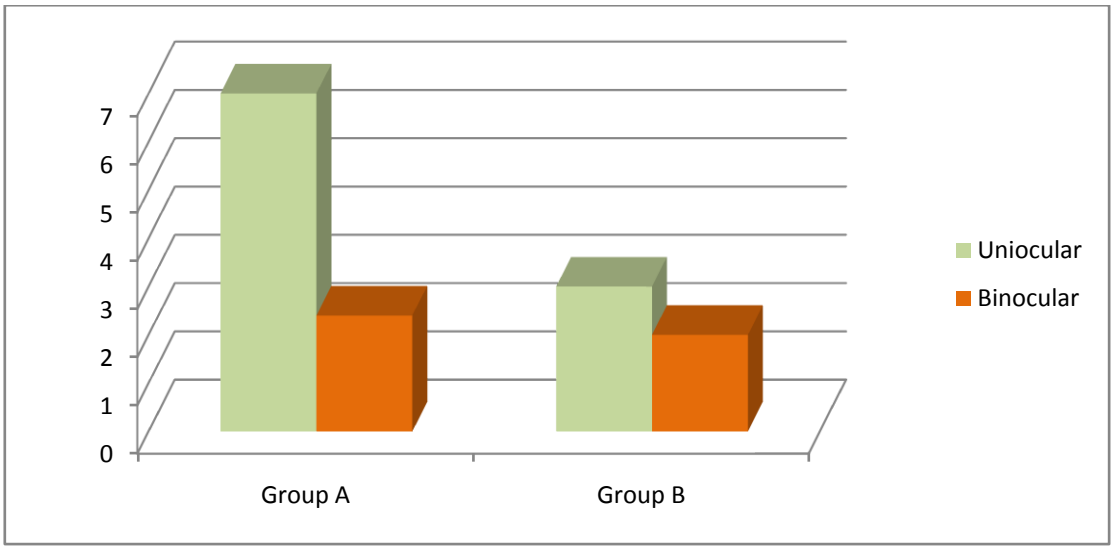


Table 4 and Graph 4

Distribution of type of amblyopia

S. No.	Type of amblyopia	No. of amblyopes	%
1.	Myopia	7	35
2.	Hyperopia	5	25
3.	Myopic Astigmatism	5	25
4.	Hypermetropic Astigmatism	3	15
Total		20	100

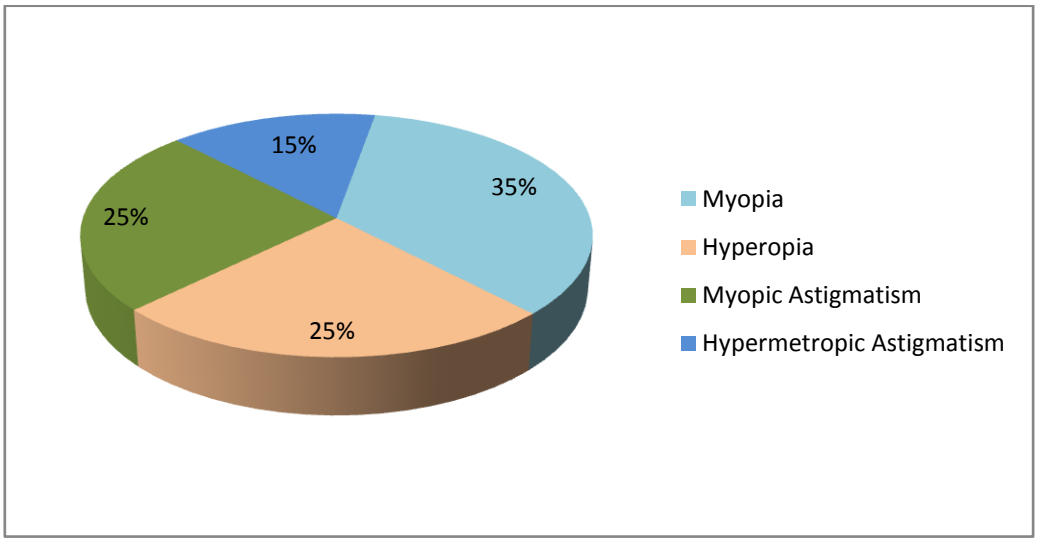


Table 5 and Graph 5

Compliance Ratio

GROUP	COMPLIANCE RATIO
Group A with MSMS having music chip	9/10 ~ 0.9
Group B with MSMS without music chip	10/10~ 1.0

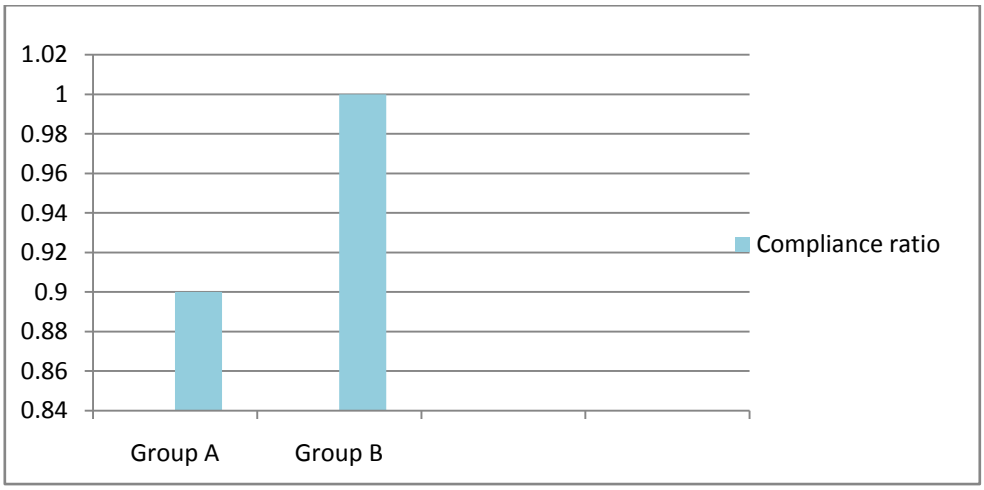
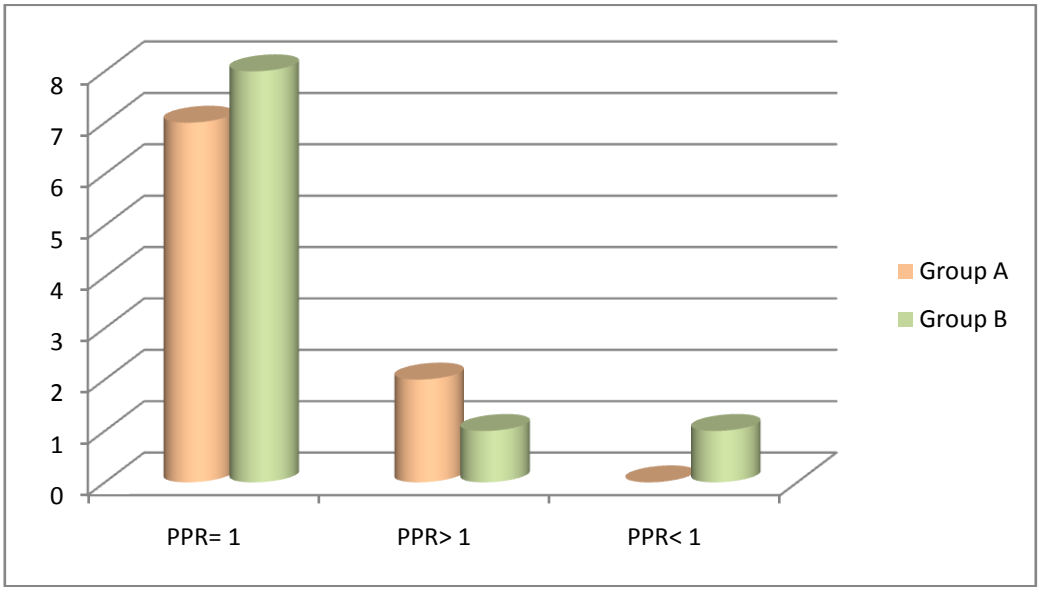


Table 6 and Graph 6

Visual outcome was better in group with MSMS integrated with music chip.

PPR	Group- A	Group- B
PPR=1	**7**	**8**
PPR> 1	**2**	**1**
PPR< 1	**NIL**	**1**



IV. Discussion

Amblyopia is a unilateral or less commonly bilateral reduction of visual acuity that cannot be attributed directly to the effect of any structural abnormality of eye or visual pathways. It is also the most common cause of unilateral visual impairment in adults younger than 60 years. Abnormal visual experience early in life results in amblyopia and can be caused by any of following:-

a) Strabismus

b) Refractive error: anisometropia or high bilateral refractive errors

c) Visual deprivation

Lack of awareness and knowledge in parents about refractive errors in children and late referrals for visual screening are a major cause of underestimation of amblyopia[7,8,9].

In our study, male amblyopia was 60% and female was 40% but the p-value was insignificant (p> 0.05). K Sapkota et al. found similar finding in their study done in Nepal[10]. Same gender preference was found in a study done by Lee et al.[11]. This gender discrepancy in our study can be explained by the fact that fewer girl

child cases are reported compared to boys in our study area. An opposite finding was found in a study done by K Anjaneyulu et al., and Park et al.[12,13].

In our study amblyopia was uniocular in 70% cases of Group A and 80% in Group B. Binocular cases were 30 % and 20% respectively in Group A and B. This finding is similar to study by Sapkota et al.[10], Anjaneyulu et al.[12] and by Menon et al.[14] in which only 7% cases were bilateral. In a study by Chung et al.[15] amblyopia was bilateral in 49% of cases.

In our study the most common cause of amblyopia was found to be myopia (35%) followed by hyeropia (25%) and myopic astigmatism (25%) and least common cause was hpermetropic astigmatism (15%). Study by Sapkota et al.[10] showed that amblyopia due to astigmatisum was most common (59.2%) followed by hypermetropia (33.5%). A recent Chinese study done by Xiao et al., found that astigmatism was present in 92% of amblyopic eyes[16}. In an Indian study done by Menon et al., amblyopia due to hypermetropia was highest (51.65%). Anisometropia amblyopia was second most common (22.1%) after strabismus amblyopia (37.38%), followed by ametropic amblyopia 12.88%, and meridional amblyopia was 5.56% [14].

Loss of vision because of amblyopia is preventable or reversible with timely detection and intervention. So, to identify children at risk for amblyopia is very important and thus regular screening throughout childhood is essential.

Traditionally, amblyopia is often successfully treated by patching the sound eye in infants and young children, but is usually considered to be untreatable in adults. A major factor for treatment failure in amblyopes is non-compliance. Other factors include recurrence and presence of residual amblyopia.

In this study we found that with our home based miniature spectacle mounted synoptophore (MSMS) compliance was excellent in both the groups.

A recent study showed that 54% of children treated with occlusion therapy at age of <3-7 years still demonstrated some amblyopia at the age of 10 year[17]. Older children were even worse; 74% of children aged 7-12 years treated with patching and, 80% treated with atropine have some degree of residual amblyopia on long term follow-up.[18]

Performance ratio was found to be better in Group A who were were given MSMS fitted with music chip. This can be due to perceptual learning.

Data from use of an occlusion dose monitor confirmed that some children in spite of excellent compliance failed to show any improvement [19]. It is generally held that the response to treatment seems best when instituted at an early age and is poor in adults, it is now clear that adult amblyopes are benefitted by perceptual learning i.e. repetitive practice of a visual task. Levi and Polat first showed that Vernier acuity in adults with amblyopia was enhanced with practice and that this improvement transferred to improvement in visual acuity in some of their observers [20]. It is now clear that perceptual learning improves amblyopic performance on a wide range of tasks, including position discrimination, spatial interaction, contrast detection, and letter recognition.

Recently home based video games, dichoptic movie viewing etc. are also being studied. In this study compliance and visual outcome was better as this SMS could be customized according to patients preference. However this is being a prototype need further refinement before commercial use.

Limitations

The study has been limited by small number of participants, limiting its application to population at large. Long term follow-up is also necessary as some studies have shown that effects of perceptual learning last for hours to months without continued practice[21].

V. Conclusion

Innovative home exercise for amblyopia is possible with trial frame mounted miniature synoptophore. This study suggests that amblyopia can be improved with the help of orthoptic stimulation by using spectacle mount synoptophore. It can improve the level of vision, at the first phase, to a certain degree for the children to accept the patching and resume their usual daily life. Thus, the compliance of the treatment can be well achieved. Science and technology are the fundamental for economic development of a country. India is developing nation with world leading technological advancements in many fields; computer technology is one of them. At the same time one fourth of blind population resides in India and most of this blindness is avoidable. We perform maximum number of cataract surgery still backlog remains. Mammoth population of more than 125 crore is cited as a reason behind all problems. But affordable Medicare and technology can help to solve this. As Einstein once said "Innovation is not the product of logical thought, although the result is tied to logical structure". For this, interaction between science and Industry is required.

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Illustrations

Illustration 1- Bioscope from local fair

Illustration 2- LED Bulbs and music chips

Illustration 3- Slides for spectacle mounted synoptophore

Illustration 4- Miniature spectacle mounted synoptophore ready to use with slits for inserting slides

Illustration 5- Underside of SMS with switches connecting LED lights to illuminate slides which can perform alternate flashing.

Illustration 6- Miniature spectacle mounted synoptophore- Ready to use

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