Advanced Amblyopia Treatment for faster and better outcomes

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Why Amblyopia?
Current definition:

• A reduction in best corrected visual acuity to 20/40 or worse or more than 1 line difference in Snellen acuity between both eyes, in the absence of disease

• Prevalence: 3%

• Etiology: Typically present in constant unilateral strabismics and/or high anisometropes with approximately 1/3 falling into each category
  - Deprivation amblyopia due to congenital cataracts is rare
Full ophthalmic correction

Occlusion Therapy

Model based on “forced” stimulation of the visual cortex from the amblyopic eye in a monocular treatment mode, i.e., occlusion therapy (patching) of the good eye.
* PEDIG research shows results in amblyopia **up to age 17**

* Dosage, ie **duration of occlusion could be reduced to 2-6 hours per day** with equal or better outcomes compared to constant occlusion

* Research protocol was occlusion therapy plus visual motor activities.
  * Patching plus atropine

**Special note:** binocular vision treatment was **NOT factored into the PEDIG research study**

**Evolving paradigms expand critical period**
* Direct complete occlusion
  * Variety of eye-patch examples

* Partial Occlusion
  * Optical- defocus
  * Bangerter foils - graded occlusion
  * Medicated Occlusion/Penalization - Atropine

* Occlusion methodology
Paradigms of Treatment

Kid

Eyepatch
Patching is no fun!
* Acuity improves but **will often regress when patching is discontinued**
* Patient typically maintains binocular suppression
* Patient often **remains “stereo-blind”**
* **Standard paradigm** patching dosage full time

* **Emerging paradigm** - based on PEDIG research, indicates patching dosage can be lowered to 2-6 hours per day

  * However, atropine penalization was still part of the research protocol resulting in visual degradation full time of the penalized eye.

* Occlusion “Dosing” regimens
* A Closer Look at Occlusion Therapy
* Disruptive to the homeostasis of the patient
* Emotionally disruptive
* Visual spatial disruptive
* Disruptive to gross motor and bilateral integration in early child development
* Disruptive to binocular vision development

* Realities of Occlusion Therapy
* Psycho-social
  * Bullying, teasing
* Emotional
  * Frustration
  * Anger
  * General unhappiness
* Danger in playing sports, crossing streets, riding bicycle, operating motorized vehicles or machinery
* Difficulty functioning in classroom or other activities in daily living

* Risk factors associated with Occlusion Therapy
Parental Understanding and Psychosocial Impact of Occlusion Therapy on Amblyopic Children and Their Parents

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Abstract

Background: It is reported that 0.2 to 5.3% of children suffer from amblyopia. The traditional treatment for amblyopia has been to correct the refractive error and occlude the non-amblyopic eye. Compliance, however, with patching is a significant problem. The aim of this study was to investigate the parental knowledge of amblyopia and its treatment. We also wanted to explore the demographic and psychosocial impact of amblyopia and its treatment.

Methods: Fifty-two parents and their children aged two to 13, undergoing occlusion therapy for amblyopia, participated in this study. Visual acuity at the initiation of occlusion therapy and the prescribed occlusion regimen were obtained from patient files. The compliance with occlusion therapy was based on self-report of the parents. The emotional impact of occlusion therapy was determined by an emotional impact questionnaire. The experiences and the difficulties expressed by parents and children were noted in their own words.

Results: Strabismic amblyopia was the most prevalent type of amblyopia, followed by isomeric amblyopia. Only 42% of the parents had an understanding of amblyopia and its treatment. However, the compliance with occlusion therapy was 78%. The occlusion therapy was a difficult experience for a majority of parents and their children. Many parents reported undue distress, difficulty, and a psychosocial impact secondary to occlusion therapy. Behavioral changes induced by occlusion therapy were also detected in 25% of children.

Conclusions: Parental understanding regarding amblyopia and occlusion therapy was lacking, but the compliance was good despite the psychosocial impact on both the child and parent.

Key Words
amblyopia, occlusion, parental understanding, psychosocial impact

INTRODUCTION

Amblyopia is a form of visual impairment characterized by abnormal neuronal numbers and connections in the visual pathway and cortex caused by the disturbance of vision during the sensitive period. It predominantly arises from interference of binocular or refractive development. Amblyopia is the most common cause of monocular visual impairment in children, young adults, and middle-aged adults. The prevalence of amblyopia has been reported to range between 0.2% and 5.3% depending on the criteria of visual acuity used and the population studied. Amblyopia is a frequent cause of lifelong visual impairment. Amblyopia can be caused by certain occlusions, affects binocular vision and stereopsis, and causes significant disability if the normal eye suffers trauma or disability.

The rationale for the treatment is to optimize visual function and binocular vision. The most common treatment options are lenses, occlusion, and vision training. Filters, prisms, and penalization with medications such as atropine and other cycloplegic drops have been considered alternatives to occlusion. In a randomized clinical trial study, it was found that substantial improvement in visual acuity of the amblyopic eye occurred with either daily patching or daily atropine treatment regimen. The difference between the patching and daily atropine treatment groups was clinically significant after six months. It was found that the weekend atropine treatment was as effective as the daily treatment for moderate amblyopia. Atropine therapy is not cosmetically obtrusive and compliance is not an issue once the drop or ointment is instilled. Side effects like flushing, hyperactivity, and tachycardia may occur, particularly in children with Down syndrome.

The mainstay treatment of amblyopia for more than 250 years has been occlusion of the better seeing eye with an opaque patch to promote visual function in the amblyopic eye. The value of occlusion in the treatment of amblyopia is widely recognized. Lack of limited understanding on the part of parents regarding amblyopia and its treatment is consistently reported as a major factor contributing to the failure of occlusion therapy. Occlusion therapy compliance is difficult to implement.

Oclusion may be prescribed in one of three time plans: continual (day and night patching), full time (occlusion for all waking hours), and part time (any time less than full time). Compliance is essential if therapy goals are to be achieved.

A recent study randomly grouped parents of children aged one to seven years into a “leaflet” group and a control group. The leaflet group was provided with written educational material while the control group was not. The concordance was monitored by a parental diary. The parent’s knowledge and the reason(s) for non-concordance were assessed by a questionnaire. The result showed that parental knowledge was significantly greater in the leaflet group (88%) compared to the control group (49%) p<0.001. Concordance was significantly greater in the leaflet group compared to the control group.

Another study was conducted with parents of children with unilateral visual impairment referred from preschool vision screening. The children were randomly assigned, receiving spectacles with or without patch, spectacles alone, or treatment that was deferred for one year. A self-completed questionnaire, including a psychometric behavioral scale, was sent to the parents of all children. The results showed that most parents reported difficulties with patching their child regardless of age (77% at age four years and 73% at age five years). Fewer reported difficulty with spectacles alone (42% at age four and 53% at age five years). Children were significantly more upset by patching than glasses only (p<0.01). Most parents thought their children were happy, cooperative, and good tempered. The behavioral score did not differ among treatment groups.

The aim of another study was to assess the psychosocial impact on the child and family for patching and atropine treatment of moderate amblyopia in children younger than seven years. In the randomized clinical trial, 419 amblyopic children with visual acuity range of 20/40 to 20/100 were assigned to receive treatment consisting of either patching or atropine. After five weeks of treatment, a parental quality of life questionnaire was completed for 364 (87%) patients. The results showed the overall amblyopia treatment index score, and the subscale scores were consistently worse in the patching group compared to the atropine treatment group (overall mean: 2.52 vs 2.82, p<0.001; adverse effect of treatment: mean 2.35 vs 2.11, p=0.02, difficulty with compliance; mean 2.46 vs 1.99, p=0.001: social stigma: mean 3.09 vs 1.84, p<0.001, respectively). It was concluded that the occlusion therapy had a greater psychosocial impact on the child and family in comparison to the atropine treatment.

Although the value of occlusion therapy is well recognized, our study goal was to explore the impact of the therapy on both children and their parents. The study also aimed to find out if parents of children prescribed occlusion therapy had an adequate understanding of amblyopia and occlusion therapy.

METHODS

Children who were undergoing occlusion therapy for one calendar year and their parents at the Department of Ophthalmology at Tribhuvan University in Kathmandu, Nepal
* Poor compliance
* Patient drops out of treatment
* Poor results
Given that occlusion therapy for Amblyopia has a track record of:

* poor outcomes
* poor compliance
* significant risk factors for “side-effects”

Why has this relatively poor track record for treatment outcomes not created a concern by most doctors in the ophthalmic community?
critical period
and
patient compliance

SCAPEGOAT
A good scapegoat is just as welcome as a solution to the problem.
*In the year 2013, isn’t there a better way to treat Amblyopia?
*“Removing the brakes” on Amblyopia treatment*

*Looking for an Advanced Treatment Paradigm based on latest neuroscience...*
*Prentice Award Lecture 2011: Removing the Brakes on Plasticity in the Amblyopic Brain
  * Dennis M. Levi
  * Optometry and Vision Science, Vol. 89, No. 6, June 2012

*Gaming the Visual System
  * Dennis Levi, OD
  * Berkeley Optometry

*Does Partial Occlusion Promote Normal Binocular Function?
  * Li, Thompson, Ding, Chan, Chen Yu, Deng and Hess

*New Amblyopia Research
* New research shows that binocular cells in strab amblyopes are intact but suppressed mechanisms are largely responsible for loss of visual function

* Monocular vision in amblyopes can be improved (even in adults!) by un-blocking suppression mechanisms

* Suppression mechanisms render the cortex functionally monocular

* Amblyopia is intrinsically a binocular problem and not the monocular problem on which current patching treatment is predicated

* Thus, treatment for the binocular problem involving suppression should be in the beginning of treatment process

* Key points of Hess research
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Research Interests

Amblyopia/clinic
Amblyopia/psycho
Contours
fMRI
Motion
Shape
Robert F. Hess
Research Interests

AMBLYOPIA

One of the main focuses of my work has been to better understand the neural loss in amblyopia. Previously, I have used contrast detection of isolated visual stimuli to delineate the loss at the fovea and across the visual field. The use of retinal evoked potentials has allowed a better understanding of the site of the neural deficit, it is cortical not retinal. Our present psychophysical studies are concerned with what extra-striate functions are affected and whether there are differential effects to the known ventral and dorsal processing pathways. So far it appears that both motion and spatial global processing are affected and that while global integration is normal, segregation is deficient. We have also developed an animal model for the positional deficits experienced by amblyopes.

Selected papers


Link to his papers:
http://www.ncbi.nlm.nih.gov/pubmed?term=Hess%20RF%5BAuthor%5D&cauthor=true&cauthor_uid=20622704
* Bangerter foils did not produce better binocular outcomes compared to direct occlusion. While they work as well as direct occlusion, they should not be promoted as an aid to developing binocular vision.

* Same with ND filters and actually more disruptive due to spatial distortions

* Optical de-focus did better than the others, but still do not as effective as binocular VT

* Key points in methods of Occlusion
Different critical periods for different functions in a sensory system (even within layers of visual cortex)

While the adult brain has limited plasticity at a cellular and molecular level, there are ways to induce plasticity

Neural connection of amblyopic eye is suppressed or inhibited rather than destroyed (critical period)

Macular degeneration example
Mechanisms of pattern vision; Influence of abnormal visual development

Research in our lab focuses on how we perceive visual forms and patterns, and how form perception is degrade by abnormal visual experience early in life (amblyopia). Specifically, we use psychophysics, computational modelling and brain imaging (fMRI) to study the neural mechanisms of normal pattern vision in humans, and to learn how they are degraded by abnormal visual experience (amblyopia). While amblyopia is known to influence the properties of neurons in cortical area V1 recent work in our laboratory suggests that amblyopia may also result in damage to higher cortical areas.

Selected Publications


* Making fine visual discriminations under conditions where the visual system is challenged
  * Learning must be intensive and active
* Age appears to have little influence on outcome of Perceptual Learning (PL)
  * The more severe the amblyopia, the more time it will take to get the maximal effect (no limits)
* Introduced idea of “gaming the visual system”
* Used adults (18-58) to play Medal Of Honor
  * All of the patients showed improvement in acuity ranging from 13-44%
  * Acuity checked every 10 hours for 40 hours
* Those amblyopes patched for 20 hours before playing the game showed no improvement in acuity

* Perceptual Learning (PL) improved acuity and contrast sensitivity in amblyopes who were not responsive to occlusion
* Act of action gaming seems to train the brain to learn, allowing for the broad transfer of learning, and thus possible improvements in the quality of life

* Neuro-modulators associated with reward may foster brain plasticity
  * Gaming aspect offers challenge and ability to progress...and more fun!
Eliminating or reducing the need to wear an eye patch in public would, at the very least reduce the emotional stress that often accompanies occlusion.

Patching itself may lead to a reduction in binocular vision and stereopsis and to psychosocial problems such as loss of self-esteem.
An advanced paradigm of Amblyopia treatment
Amblyopia is due to a disruption in infant and toddler binocular vision development.
Neuroscience research shows Amblyopia is a condition where active inhibition occurs between the normally fixating eye and the amblyopic eye.

This active inhibition is otherwise known as “suppression.”
“...strabismic amblyopes possess cortical cells with binocular connections but that under binocular (and to a lesser extent, monocular) viewing, suppressive mechanisms render their cortex functionally monocular. The consequence is that amblyopia is an intrinsically binocular problem and not the monocular problem on which current patching treatment is predicated”.

Hess...the role of binocular vision
* An advanced paradigm of Amblyopia treatment

* Binocular Vision Therapy
* Perceptual Learning strategies
  * Top Down model utilizing technology, video games and related challenging activities
* Plus all of the tenants of developmental vision therapy
The advanced Amblyopia Treatment paradigm

Begins with best practice methods of Lens Prescribing
* **Begin** with MFBF (monocular fixations in a binocular field)

* Equate monocular skills
  * Oculomotor
  * Accommodative
  * Visual spatial awareness judgments
  * Visual processing (eg. Tachistoscopic activities)

* Contrast sensitivity development
* **Advanced Amblyopia Treatment Paradigm**
  
  Office-based vision therapy
  
  * **Binocular**
    * Stereopsis ASAP!!
    
  * **1st Degree - Simultaneous Perception**
    * Physiological Diplopia
    
  * **2nd Degree - Flat Fusion**
    * Brock String, BC 520
    
  * **3rd Degree - Stereopsis**
    * Quoits, VTS-4 and others
    
* Expand ranges of fusion - variety of techniques
* The advanced Amblyopia Treatment Paradigm also adheres to developmental vision principles

* Gross Motor, bilateral integration
* Visual-motor integration
* Central- Peripheral integration
* Visual- Vestibular integration
* Monitoring outcomes

* Visual Acuity
  * Single letter, Single row, Full chart
* Stereopsis (distance and near)
  * Wirt
  * Random Dot
* Contrast Sensitivity Function (CSF)
* Sensory Fusion
  * Monitor for Central Suppression
The standard Amblyopia treatment paradigm versus The Advanced Amblyopia treatment paradigm
The standard Amblyopia treatment paradigm

* Acuity improves but will often regress when patching is discontinued

* **Treatment often discouraged past age 10**

* Patient often experiences emotional and psycho-social trauma with standard patching

* Patient at greater risk of accidents while patched

* Patient maintains binocular suppression after treatment

* Patient often remains “stereo-blind”
* The Advanced Amblyopia treatment paradigm

* Binocular vision therapy removes the brakes on a critical period
  * Age is not a barrier to treatment
* Occlusion dosage reduced to only a few minutes a day
* Patients are not at risk of being emotionally traumatized
* Patients at no greater risk of injury by the disorientation
* The patient will have a more enjoyable experience in treatment, thus compliance problems eliminated
* Binocular suppression is eliminated
* The patient gains stereopsis...3-D vision
*The Advanced Amblyopia treatment paradigm*

...removes the brakes of suppression, accelerates binocular vision, stereopsis and visual acuity and thereby gives the patient the chance to realize their true potential!
* Prentice Award Lecture 2011: Removing the Brakes on Plasticity in the Amblyopic Brain Dennis M. Levi
Optometry and Vision Science, Vol. 89, No. 6, June 2012
* Gaming the Visual System Dennis Levi, OD Berkeley Optometry
* Does Partial Occlusion Promote Normal Binocular Function? Li, Thompson, Ding, Chan, Chen Yu, Deng and Hess
* The psychosocial and emotional consequences of occlusion therapy....an antiquated treatment for amblyopia, Dan L. Fortenbacher, OD- The VisionHelp Blog
* New Scientific Evidence for Amblyopia Treatment...Two Eyes are Better than One!, Dan L. Fortenbacher - The VisionHelp Blog

Resources