AMBLYOPIA: A REVIEW

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Amblyopia is defined as the condition of reduced visual acuity not correctable by refractive means and not attributable to obvious structural or pathological ocular anomalies.[2] It is presumed that the best possible farpoint corrective lenses are worn during the testing of visual acuity. In general, vision worse than 20/30 is considered to meet the criterion for amblyopia. This is also true when there is a significant difference in the best correctable acuity of each eye. For practical purposes, if the acuity difference is two lines of letters on the Snellen chart, amblyopia of the poorer eye may be present.[3] (p74)

Volumes of information and research exist in regards to amblyopia. Three of the most common facts known about this condition are listed below.

One, when amblyopia is not successfully treated in childhood, the patient must live an entire lifetime with the risk of suffering serious disability from an injury to the good eye.[1] (c11p1) Given that 50,000 eyes are lost to trauma or disease annually in the United States,[2] the likelihood of such an occurrence is not insignificant.

Two, it is commonly stated in the lay press and other media and from the professional lecture platform that there is no proven effective therapy for amblyopia in children older than nine years of age.[15]

Three, historically amblyopia has been treated with

occlusion therapy. In fact, occlusion therapy for amblyopia has been in use for more than 2 centuries[1] (c11p6). Occlusion of the good eye is currently the treatment of choice[5] and success rates have been reported ranging from as low as 30%[31] and as high as 92%[32].

With these facts in mind this paper, through a review of the literature, will address techniques, other than patching, that practitioners have used in reversing amblyopia in both adults and in children. Furthermore, it will discuss how successful these techniques were.

ROTATING GRATINGS

One of the most prevalent therapies for amblyopia, other than just occlusion, involves the area of rotating gratings in conjuction with subsequent occlusion. In 1978, Campbell et. al proposed this new therapy for the treatment of amblyopia.[6] This treatment involved stimulation of the amblyopic eye by slowly rotating high-contrast square-wave gratings of different spatial frequencies. The better eye was patched only during this brief period and remained open between the weekly treatment sessions.

Campbell presumed the gratings to be a far more effective stimulus than that provided by every-day surroundings.[7] This assumption was based on psyco-physical and neuro-physiological experiments, which had demonstrated that gratings represent a specific stimulus for visual cortical neurones.[8] Campbell, therefore, referred to the new therapy as the first "physiologically based treatment of amblyopia."[6]

In this original trial the results confirmed the author's assumption: the visual acuity of all twenty-two subjects improved and, in many of them, after one single stimulation period of seven minutes. Thirteen of these twenty-two patients obtained a visual acuity of 6/9 or better after a mean duration of six seven-minute treatments.[6]

Even though the initial results of this trial appeared successful, the success of the CAM-treatment in human amblyopes was regarded with scepticism by many strabismologists.[9] It seemed difficult to accept that stimulation with gratings over periods as short as seven minutes should be more effective than conventional occlusion, which also provides the amblyopic eye with a wide spectrum of high contrast patterns of widely differing orientations and spatial frequencies.[10] And,indeed, many subsequent studies have shown that this scepticism was warranted.

One of these studies was by Medhorns et. al.[10] This group was concerned about the impossibility of distinguishing between a specific effect of the grating stripes and the influence of other nonspecific factors, such as repeated vision testing, improved co-operation, high motivation of the patient and his therapist, and the "minimal occlusion" itself.[10] This group of therapists wished to clarify whether the gratings themselves really had a *specific* effect. They compared the CAM-treatment described above with a modification using rotating black and white pictures instead of stripes. Results showed that in both groups (one viewing rotating square-wave gratings and the second

viewing rotating black and white pictures) only slight visual improvements resulted. The authors attributed this slight improvement in acuity to the repeated testing of visual acuity and nonspecific effects of short-term occlusion. (The authors of this study were only able to get a clear improvement in acuity after subsequent long-term occlusion.)

A second trial studying the effects of using rotating gratings for the treatment of amblyopia was done in 1980 by Schor et. al.[11] This was also a variant of the original work done in Cambridge in 1978. In this particular trial a treatment group observed rotating gratings for 15 minutes per week for 10 weeks and a control group observed a blank rotating disk for the same period. Both groups of amblyopes performed visually guided tasks to maintain their interest during treatment and data were acquired in a double-masked manner. Again, the results were not near as successful as some of the original work. The authors of this study concluded that rotating gratings were an insignificant variable in the treatment of amblyopia.[11]

Another group, comprised of Keith, Howell, Mitchell, and Smith, performed a similar trial and obtained the same discouraging results.[12] As in Schor's group, Keith et. al had one group of amblyopic children viewed a series of rotating gratings during treatment, while a second group performed exactly the same visuomotor tasks against a homogeneous grey background. The difference in vision between the two groups was not statistically different.[12] As in Schor's group, Keith's group attributed most of the visual recovery to some aspect of

the procedure other than the rotating patterns.[12]

Neither of two other articles reviewed gave much hope for the use of rotating gratings in the treatment of amblyopes. Carruthers, Pratt-Johnson, and Tillson summarized their 1980 trial by saying that future studies were "needed before a claim (could) be made that...gratings per se offer an improved method of treatment of amblyopia."[13] Another study, this one by Schor and Wick, showed that the use of rotating gratings in the treatment of amblyopia, in patients with and with out eccentric fixation, did not reveal a significant improvement of visual acuity.[14]

LEVODOPA

Because the neurotransmitter dopamine (DA) is involved in several visual functions,[16] some researchers have begun to study how its administration to amblyopes would affect the condition. It is known that visual deprivaton decreases retinal DA concentration in chickens[17] and monkeys.[18] If is further known that catecholamines and other neurotransmitters, such as GABA , acetylcholine and glutamate are involved in neuronal plasticity in deprivation amblyopia and can restore partial visual acuity in adult cats.[19,20]

With this in mind, Gottlob and Strangler-Zuschrott[16] undertook a study to investigate the short-term effect of levodopa (a precursor for the catecholamine dopamine[25]) on contrast sensitivity and binocular suppression in human adult amblyopic patients. Using a cross-over, double-masked study the

two examined the influence of levodopa on contrast sensitivity, binocular suppression, and visual acuity in human adult strabismic and amblyopic patients. After one single administration of levodopa, the authors found a significant increase in contrast sensitivity and decrease of the size of the fixation point scotoma was found. These changes were not detected in the control group that was administered a placebo. When visual acuity was measured (using the tumbling E), only 22% of the patients involved showed a significant increase in acuity.[16]

Two years later Gottlob, Charlier, and Reinecke did a similar study.[21] In their study, they investigated the effect of levodopa after one week of daily administration (versus one single administration in the first study). The results of this study also showed some improvement. There was an improvement in visual acuity in 70% of the patients after this one week of levodopa administration. Even more encouraging was the fact that some of the improvements in visual acuities persisted even after the levodopa administration was completed.[21]

Even though this group of clinicians got positive results in this trial, they admit that the mechanism of action of levodopa remains unclear.[21] Because dopamine is present in the human retina[22] and also appears to be involved in visual information processing to the brain,[23,24] the dopanergic effect cannot be localized to a specific part of the visual pathway.[21] It *may possibly* be explained due to the fact that the visual cortex (Brodmann area 17) incorporates dopaminergic terminals.[26]

Along with the fact that the mechanism of action of levodaopa in the treatment of amblyopes is unclear and needs to be investigated further using higher doses with longer duration of administration,[21] there is one more thing about the administration of levodaopa that needs to be addressed: its side effects. One study[15] revealed a high prevalance of side effects. These side effects included nausea in four of seven subjects. These side effects, certainly, would limit the number of patients would might be able to benefit from this form of treatment.

EXTENDED WEAR SOFT CONTACT LENSES

Because occlusion therapy demands a great deal of attention and determination from the patient's parents[1] and is often meant with a negative response from the child, some people have experimented with the idea of using an extended wear soft contact lens, of either a high plus power or with a black center[27,28,29], to occlude the patient's eye. This, in theory, would give much, if not all, of the same benefits of occluding with a patch, and still allow the patient to avoid the social stigma many associate with wearing a patch. Furthermore, the child would not be trying to remove the patch and would not need constant surveillance of the parent or guardian.

One such trial was done by J. Elmer et. al [30]. In this trial 17 amblyopic children between four and nine years were fitted with high power plus extended wear soft contact lenses for optical occlusion of their strabismic amblyopia.

This results of this trial were very successful. The amblyopia responded quickly to treatment between 2 to 13 weeks. Only one patient failed to reach acuity of 6/9, and 11 patients achieved equal visual acuity.

Even though the contact lenses were well tolerated by the children in this trial,[30] there are still the same drawbacks and side effects that occur in any one who wears contacts. These include, but are not limited to, deposits, loss of lenses, and infections.

After having reviewed some of the possible treatments for the condition of amblyopia, let us now address the question of when, if ever, it is too late to reverse the vision loss in amblyopes. This was the question address in the 1992 paper "Anisometropic Amblyopia: Is The Patient Ever Too Old To Treat?"[33] In this article the authors studied 19 patients over the age of six.

The clinicians in this case used a sequential management program that consisted of four steps. These steps were: (1) use of the full refractive correction, (2) added lenses or prism when needed to improve alignment of the visual axes, (3) 2 to 5 hours per day of direct occlusion, and (4) active vision therapy to develop monocular acuity and improve binocular visual function.

Results of this trial found increased visual acuity in all 19 of the subjects, and an increase of all the way to 20/20 in 42.1 percent of the patients (8 of 19).[33]

Another study, this one in 1986, compared the success of reversing amblyopia in younger children (below the age of eight) to the success in an older group (eight years of age and up).[34] In this particular study, younger children were significantly more compliant than older ones and, as a consequence, was probably the primary reason for the higher incidence of treatment failure in older children. However, of the older children who complied with therapy, they also showed a marked improvement in visual acuity.[34]

It is also worth mentioning that in each group involved, most of the improvement occurred during the first three months of treatment. Improvement after this period was marginal.[33]

A third report is a retrospective study of treatment of refractive amblyopia in adults.[37] With a combination of occlusion therapy and visual efficiency exercises all ten patients had some improvement in their visual acuity. The average patient began with approximately 20/50 vision in the amblyopic eye, and after the therapy program finished with a mean of 20/25.[37]

Aside from these examples of reversing amblyopia in older children or in adults, lots of information about the potential of improving vision in the amblyopic eye comes from reports on adult amblyopes who have lost vision in their good eye. Several examples exist in the literature documenting improvement in these cases. A few are discussed below.

One such report, by Hamed et. al.,[35] documents improvement

in Snellen visual acuity of the functionally amblyopic eye in each of three adults, ages 54, 70 and 72 years old, following ischemic optic neuropathy in the contralateral sound eye. In these three cases Snellen visual acuities of the amblyopic eyes improved respectively from 20/200 to 20/20; from 20/80 to 20/40+2; and from 20/400 to 20/50+2. The visual acuity improvement occurred over several days to weeks.[35]

A second example does not get quite as impressive results. In Vereecken and Brabant's 1982 paper[36] they find that amblyopes who lose their good eye have only a 28.5% chance to obtain a visual acuity of 3/10 or more.

CONCLUSION

This paper discussed just a few of the various techniques that have been attempted in the treatment of amblyopia. Rotating gratings, though initially appeared to be an encouraging alternative to patching, has been disputed by several to be ineffective. The administration of levodopa has shown some initial success, but needs further research. The use of high powered lenses has a history of being very successful. This is not surprising as it is very similar to patching.

This paper also examined the question of at what age you can still treat amblyopia. It would appear that there is not a concrete "critical period" and that treatment could be considered at any age.

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