Direct comparison of eye patch and virtual occlusion during computer-aided treatment of amblyopia in children

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Introduction & Purpose

Amblyopia – or "lazy eye" – is a widespread disorder, manifested as visual function impairments despite seemingly normal condition of the eye and visual pathways.

Traditionally, for amblyopia treatment, the complete occlusion of better eye (**patch occlusion**) is used to involve the worse eye into the vision process. Various schemes of occlusion procedures can be applied, but all of them are targeted on monocular vision improvement.

Nowadays, there is an alternative to the full occlusion: **virtual occlusion** (=dichoptic training).

The **purpose**: to compare the effectiveness of virtual occlusion (**VO**) and patch occlusion (**PO**) for amblyopia treatment in children.

Some recent investigations [1-5] evidenced that, in treating amblyopia, virtual occlusion (dichoptic training) could have significant advantages over eye patches. However, the data available are mostly obtained in adults and still seem to be preliminary and not fully comprehensive.

Extending our previous works [2, 5], we have provided comparison of VO and PO:

- in groups with equal number of disbinocular and refractive ambliopes;
- with the same stimulation (the same computer program);
- with assessment of accommodation, binocular function, visual acuity (of trained eye, non-trained eye, and binocularly).

Virtual occlusion & Patch occlusion

Eye-patch occlusion (PO) - full occlusion, "turning off" the better eye from the visual process.

(The picture is taken from: https://www.etsy.com)

Virtual occlusion (VO) - adjustable occlusion, realized by means of 3D technique.

One of advantages of VO is good visibility of environment, meanwhile the game image is less contrast.

Virtual occlusion was provided by using polarized 3D technique: passive 3D-glasses and the 3D monitor LG Flatron 32LF620U.

For **amblyopic eye**: high contrast. 100% visibility.

For **better eye**: less contrast. We used gradual increase: 0% (not visible at all), 25%, 50%, 75% visibility.

Stimuli е з щ

Subjects & Procedure

I group 30 amblyopes: *10 sessions by 5 min* Patch occlusion (PO) → *10 sessions by 5 min* Virtual occlusion (VO)

II group 29 amblyopes: *10 sessions by 5 min* Virtual occlusion (VO) → *10 sessions by 5 min* Patch occlusion (PO)

The first group underwent treatment with PO sessions then VO sessions (PO/VO).

The second group – in inverse order (VO/PO).

The training distance - 50 cm.

Groups description:

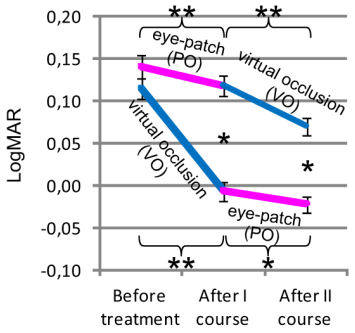
Groups of patients	Type of amblyopia	Number of patients	Age	Number of hypermetropic patients	Number of myopic patients
I group (PO then VO)	Disbinocular*	15	8-14 yr mean 10,5±0,7	10	5
	Refractive	15	8-13 yr mean 10,2±0,6	10	5
II group (VO then PO)	Disbinocular*	14	7-14 yr mean 10,2±0,6	8	6
	Refractive	15	7-14 yr mean 10,1±0,6	11	4

During the experiment and during 6 months before, patients have no other treatment of amblyopia.

*Previously, the angle of strabismus was eliminated by surgical operation or optical correction

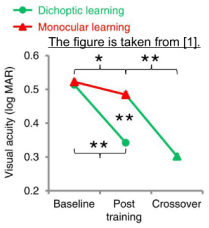
Results

Binocular visual acuity



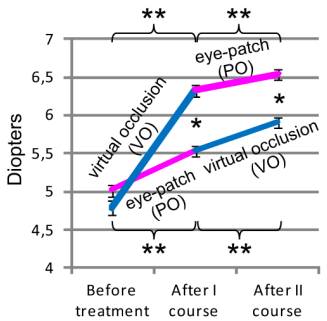
In both groups we observed significantly greater improvement of binocular visual acuity after VO than after PO.

In all graphs on this poster asterisks denote statistical significance (t-test, * = p < 0.05, ** = p < 0.001) and error bars show standard error of the mean.



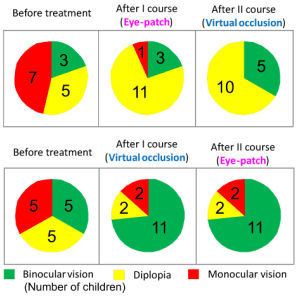
Our results are consistent with data obtained in our previous work and seems to be very agreed with other athors, for example [1].

Accommodation



We have received positive results after PO as well as after VO.
After I course we received significantly better results with VO than PO (p<0.05).
After II course we received better results for VO (increase on 0.37±0.06 diopters) than for PO (increase on 0.22±0.06 diopters), but the difference is unreliable (p=0.085).

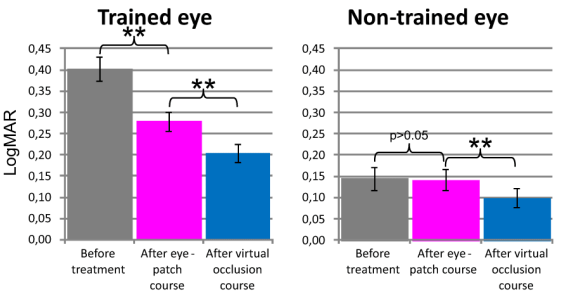
Binocular function



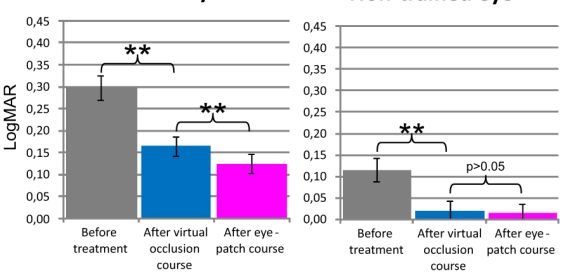
We used Bagolini test on 50 cm distance.
Only disbinocular amblyopes' data are presented. All refractive amblyopes demonstrated binocular vision.
Binocular functions seem to show more progress after VO course than after PO course.

Monocular visual acuity

PO → VO training



VO → PO training



We observed significant improvement of visual acuity after VO as well as after PO on the **trained eyes** in both groups.

Improvement by VO and PO were not statistically different.

To our surprise, on a **non-trained** eye we observed a significant improvement of visual acuity after VO in both groups.

After PO there were no statistically reliable changes.

Conclusions

The results obtained show the following advantages of virtual occlusion:
- improvement in **monocular visual acuity** of both eyes (trained and *even* non-trained);
- improvement in **binocular visual acuity** more pronounced after VO then after PO.

Additionally, improvement in **accommodation** and **binocular function** seems to be more prominent after VO than after PO.

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Some recent investigations evidenced that, in treating amblyopia, virtual occlusion (VO) could have significant advantages over traditional occlusion with eye patches (PO). However, the data available are mostly obtained in adults and still seem to be preliminary but not comprehensive. In order to compare the effectiveness of using PO and VO in children directly, we employed PO in some training sessions and VO (realized by means of 3D technique) in others. The same sets of visual stimuli and identical training procedures were used in the courses of treating amblyopia (10 sessions by 5 minutes) in two groups of children aged 7-14 years. The groups had 15/15 and 15/14 patients with disbinocular/refractive amblyopia and similar characteristics as concerned distributions of age and initial visual acuity. The first group underwent treatment with PO sessions then VO sessions (PO/VO), the second one – in inverse order (VO/PO). For the amblyopic eyes designed to treatment, the training procedures PO/VO and VO/PO produced increase in visual acuity 35%/20% and 38%/10%, respectively. In the case of VO, significant improvement in visual acuity was also registered in the paired eyes (by 25%/11% after first/second course), while in the case of PO, visual acuity in these eyes remained unchanged. In addition, employment of VO results in significant increase of binocular visual acuity (by 33%/12% after first/second course).

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Teaser:

Direct comparison of eye patch and virtual occlusion during computer-aided treatment of amblyopia in children

Significant advantages of virtual occlusion (realized by means of 3D technique) in treatment of refractive and disbinocular amblyopia in children were revealed: increase in visual acuity not only in amblyopic eye designed to treatment, but also in paired eye, and increase in binocular visual acuity.