Treatment of Visual Field Defects After Stroke

Background

Homonymous visual field defects are a common outcome after stroke and create a marked amount of subjective inconvenience in everyday life. Unlike in other impairments caused by stroke, e.g. motor dysfunction or aphasia, training protocols for visual field defect have not been introduced to common clinical practice. Nevertheless, several training methods have been studied (see table 1). An ideal training method would enlarge the patient's field of vision and improve the patient's coping in everyday life both subjectively and objectively. In this review, we introduce the most studied training protocols for visual field defects and outline the possible future use of the methods in clinical practice. We will focus on pure visual field defects excluding patients with visuospatial neglect.

Methods of treatment

The methods of treatment can be divided into restorative, compensatory and substitutive[1] (see table 1). Restorative methods enlarge the visual field measured by high-resolution or conventional perimetry. Kasten, Sabel and co-workers have presented a computer-assisted training method, which they have shown to be effective in enlarging the visual field after 6 months of intensive training in hemianopic patients with chronic post-chiasmatic lesions of varying etiology[2]. Later, they have shown that the patients can show either further improvement, stability or decrease in performance after a follow-up of about 23 months[3]. Our own studies with computer-assisted training in chronic stroke patients have been successful in inducing visual field enlargements in some patients, also with sustained effects after a follow-up of three months without training[4]. In our programme, the patient sits in front of a computer screen and responds to blinking dot stimuli that are directed to the borderline region between the intact and the blind visual fields. See figure 1 for an example of training results.

Saccadic eye movement training has been studied already earlier and it has been shown to enlarge the visual field in homonymous hemianopia, and also specifically in stroke patients[5,6]. In saccadic training, cued light stimuli or other targets are presented in the blind hemifield. In the search of the stimuli, eye movements are allowed. Visual field enlargements have not been found in all studies based on saccadic eye movements, but improvements in visual exploration technique and extension of the visual search fields have been shown[7].

Compensation training of eye movements on a large board can improve performance in both acute and chronic stroke patients[8]. This effect is sustained at a later follow-up, but does not diminish the size of the scotoma in visual perimetry.

Substitutive methods, such as prisms, have been used as an optical aid for hemianopic patients, but the patients' co-operation has been poor, but is better with a monocular prism that expands the field of vision without double images[9].

Which treatment, when and to whom

For the applicability of these treatments, it would be necessary to define when treatment should be started and to whom it should be offered.

A prerequisite for the use of computer-assisted restitution training is the preservation of some residual vision (areas of the visual field that do not function normally but have potential)[10]. Sabel and coworkers also recommend that the computer-assisted training program should be performed daily for at least half a year, it should be adjusted individually and according to progress, and the patient should not suffer from photosensitive epilepsy or inflammatory eye disease. Restitution training aims to enlarge the visual field either permanently, which has been shown in some patients, or to keep up the enlarged field by continuous training. Saccadic search methods on large boards would probably be most suitable for patients who mainly have difficulties in coping in everyday situations, e.g. in traffic, as the large board corresponds to the natural normal field of view[8]. Prisms could be tried for some patients who cannot participate in training procedures but who suffer major inconvenience due to the defect and deficits especially in peripheral vision.

Of the studies mentioned, Kasten and coworkers[2] as well as Julkunen and coworkers[4] have focused on chronic stroke patients, but all others have included patients in both the acute and chronic phase of stroke. Thus far we can say that computer-assisted treatment helps many patients in the chronic phase. None of the treatment studies have included only acute or subacute stroke patients. Timing of spontaneous recovery and knowledge of brain plasticity suggests that interventions during the acute phase (maybe not during the first month) could be more effective than later efforts. Spontaneous recovery during the first months may also indicate probable responsiveness to treatment later on. A randomised study with acute patients only would be necessary.

More information is also needed on the selection of the patients to training programmes. Functional imaging techniques, mainly fMRI, could be helpful in revealing patients who have the best chance of treatment response - this is an eagerly awaited area for future studies. Moreover, it is not perfectly clear whether the location or the size of the lesion affect the treatment outcome, e.g., whether patients with occipital cortical lesions are more responsive to treatment than patients with subcortical lesions.

Conclusions

It seems evident that many patients with visual field defects benefit from training, but certainly not all of them. Currently, it is nearly impossible to select those patients who would definitely benefit from visual field treatment. At least in chronic stages a sufficiently long and intense period of training (almost daily for months) will be needed to gain benefit. On the other hand, if the treatment is easy to access and to use and is not costly, there should be no objection to trying it out.

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Figure 1

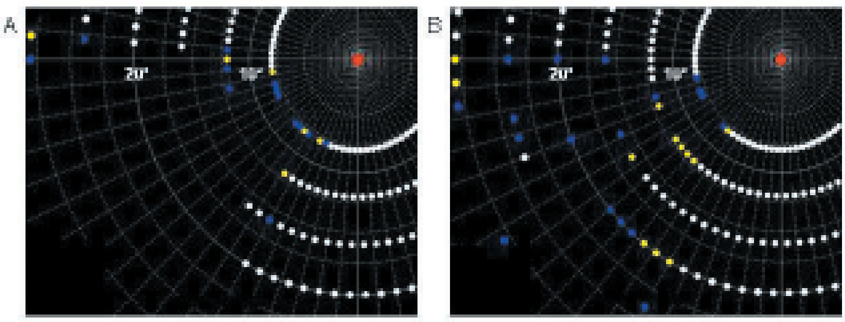

Figure 1. Result charts of the training program applied by Julkunen and coworkers.

Result charts of one patient in the beginning (A) and in the end of the training period (B). The visual field defect is in the left lower quadrant of the visual field, which is displayed in both charts. The fixation point was in the right upper corner of the computer screen. The area trained was 8-28º from the centre of the visual field. The area that has been partially or normally seen has enlarged during the training. White dot = normal vision (over 3/5 stimuli seen), yellow dot = relative defect (2/5 stimuli seen), blue dot = relative defect (1/5 stimuli seen), black area between 8º and 28º = absolute defect (0/5 stimuli seen), red dot = fixation point.

References:

1. Kerkhoff G. (2000) *Neurovisual rehabilitation: recent developments and future directions.* J Neurol Neurosurg Psychiatry; 68:691-706.
2. Kasten E, Wüst S, Behrens-Baumann W, Sabel BA. (1998) *Computer-based training for the treatment of partial blindness.* Nat Med;4:1083-1087.
3. Kasten E, Muller-Oehring E, Sabel BA. (2001) *Stability of visual field enlargements following computer-based restitution training – results of a follow-up.* J Clin Exp Neuropsychol;3:297-30.
4. Julkunen L, Tenovuo O, Jääskeläinen S, Hämäläinen H. (2003) *Rehabilitation of chronic post-stroke visual field defect with computer-assisted training.* Restor Neurol Neurosci;21:19-28.
5. Kerkhoff G, Münßinger U, Meier EK. (1994) *Neurovisual rehabilitation in cerebral blindness.* Arch Neurol;51:474-481.
6. Zihl J, Von Cramon D. (1985) *Visual field recovery from scotoma in patients with postgeniculate damage. A review of 55 cases.* Brain;108:335-365.
7. Pommerenke K, Markowitsch HJ. (1989) *Rehabilitation training of homonymous visual field defects in patients with postgeniculate damage of the visual system.* Restor Neurol Neurosci;1:47-63.
8. Nelles G, Esser J, Eckstein A, Tiede A, Gerhard H, Diener HC. (2001) *Compensatory visual field training for patients with hemianopia after stroke.* Neurosci Lett;306:189-192.
9. Peli E. (2000) *Field expansion for homonymous hemianopia by optically induced peripheral exotropia.* Optometry and Vision Science;77:453-464.
10. Sabel BA, Kasten E. (2000) *Restoration of vision by training of residual functions.* Curr Opin Ophthalmol;11:430-436.

Table 1. Training methods for visual field defects after stroke.

Method	Study	Patients	Age of lesion	Amount of training	Evidence and patient benefit
Restitution					
Computer-assisted visual restitution training	Julkunen et al 2003	5	18-48 months	3 months, 1 hour 3 days/ week	VFE 5-10° in 3 patients Subjective benefit in 4 patients
	Kasten et al 1998*	19	6.8 yrs ± 11.4 months	6 months, 1 hour/ day	VFE 4.9° ± 1.7 Subjective benefit in 72.2%
Saccadic training	Kerkhoff et al 1994	22	1-37 months	5 weeks, 30 min 5 days/ week	VFE 2-24° in 12 patients and extension of the visual search field Subjective benefit
	Pommerenke and Markowitsch 1989*	10	8 weeks - 4.7 yrs	10-15 sessions of 80-120 trials	No VFE Improvement in visual exploration, extension of the visual search field
	Zihl and Von Cramon 1985*	55	1-28 months	Daily or at least 3 times/ week 80-120 trials per session as long as improvement occurred	VFE 1.5-38° Subjective benefit in patients with central or large peripheral VFE
Compensation					
Visual exploration training with large saccades	Nelles et al 2001	21	0.5-24 months	4 weeks, 30 min twice/ day	No VFE Improvement in detection of and reaction time to visual stimuli with use of exploratory eye movements
Substitution					
Prism adaptation	Peli 2000*	12	Not indicated	3 weeks-18 months	VFE with prism Subjective benefit in 9 patients

*patients with other post-chiasmatic lesions, e.g. trauma, also included, VFE = visual field enlargement