

## Visual Field Defects and Binocularity in Cases of Age-Related Maculopathy and Glaucoma

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### Abstract

The relationship between visual field defects, consecutive onset of squint and double vision has been studied for diseases with slowly progressive deterioration: 1.) Age-related maculopathy, characterized mainly by central scotomas which can be incomplete, quasi sievelike and allow to maintain fusion; if they are dense, without isles of intact retina or extent over the visual field, fusion will be interrupted and one eye will drift into divergence. These patients see the developed double pictures only partly due to a local lack of perception. An example: The frame of the TV-screen appears with shifted double contour but the speaker in the centre is seen single. We have called this anomaly "peripheral diplopia"; the degree of shift indicates the squint angle. Other patients report indistinct symptoms like seeing clouds, blurred vision or the repeated closing of one eye to see better; these statements allow no diagnosis but may raise the suspicion of binocular problems or not perceptible double vision; these complaints we classified to be "masked diplopia", because after prismatic squint correction they vanish at once. 2.) Glaucoma patients have fewer binocular problems, diplopia arises late when the binasal visual defects reach the macular region and fusion- and convergence- insufficiency cause a divergent eye position; by prism correction the reading ability can be restored. The years before this event the patient may have had asthenopic complaints caused by fusion weakening consequent to retinal decay; he realizes only serious deterioration of vision. The loss of fusion power is most aggravating where the function is the best: In the region between 2° and 10°-12° eccentricity from the foveola. The aim of this paper is to point out that indistinct complaints of elderly patients may indicate binocular problems or even diplopia.

**Keywords:** Visual Field Defects and Fusion Power; Masked Diplopia; Peripheral Double Pictures; Exotropia; Prism Correction

### Introduction

#### Central and peripheral vision

An ophthalmologist primarily will check the patient's sensorial functions of the retinal center noted as "Visual Acuity"(VA). The visual perception of the retinal periphery, the "visual field" will commonly be recorded only secondarily for neurological cases and for the eyesight test required for a drivers license.

While central vision allows to differentiate details of certain objects, peripheral vision informs us about the surroundings in which we live as well as our subjective localization in free space; moreover the peripheral perception allows to see moving objects and gives calculated impulses for eye movements.

Between central and peripheral perception, there exists a sort of rivalry. Imagine, you are walking in a street, you are surveying many facts happening; the moment you turn your attention to fixate one certain person or object, the other proceedings in the street will vanish. This behavior is a normal condition provided that the eyes position is straight. The most important functional connection between both eyes is fusion based on central and peripheral perception. But the power of fusion is not equal in every part of the binocular visual field. The aim of this study has been to find out which size of a scotoma and which position within the visual field are decisive for a break-down of fusion followed by the onset of strabismus with double vision.

## Materials and Methods

### The patients

All patients included in this study showed ophthalmological diseases which cause progressive visual field defects of one or both eyes; most frequent were age-related maculopathy and glaucoma. Excluded were patients having pre-existent squint or loss of visual field based on neurological diseases.

### Age-related maculopathy and binocularity

57 Patients, aged 46 - 90 average 73.8 yrs, were suffering from the late-stage of wet maculopathy with tumor-like fibrous degeneration, most of them only in one eye. 32 patients had lost reading ability of their worse eye, the vision of the master-eye being good or moderately reduced. No patient had other ophthalmologic pathologies.

### Binocular examinations

In the absence of bifoveal fixation the common methods of orthoptics are not practicable: The synoptophore, the cover-tests or the red-glass method. Therefore the angle of squint was measured by the Krimsky test, for fusion testing the striated glasses by Bago- lini were used and for coarse stereo perception the Hit test.

### Recording of the visual fields under binocular conditions

The phase difference haploscopy after Aulhorn was used which allows a separated perception of both eyes in free space under natural conditions. The master eye was fixing a central spot while the impaired eye simultaneously was checked with a moving mark. Thus, we were able to define the size of the scotoma and its position in relation to the fixation point. During these examinations we found out that short moments of seeing the test mark may occur within a large field without perception, and the patients must be instructed to observe this events. These incomplete skotomas are called "sievelike" and play an important role for the power of fusion.

### The relationship between visual field defects and onset of squint

No squint showed 25 patients independently of their age. The extent of the scotomas varied: 16 patients had only small central defects between 2°-13° diameter including isles of intact retina; 9 patients had scotomas of diameter 15°-50° extension, but they were sievelike, either central or in an eccentric position.

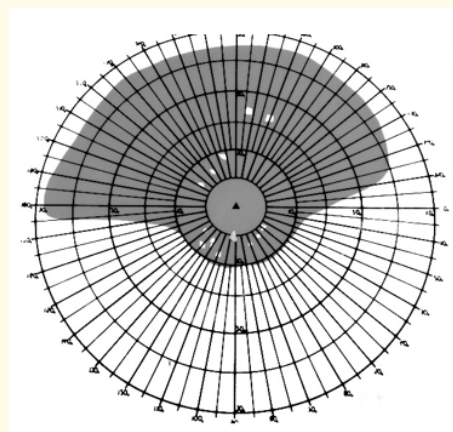


Figure 1: Sievelike scotoma, no squint position.

Strabismus had developed in 32 patients for only one distance or for both:

- Looking into far distance: 10 cases were divergent and 4 convergent.
- For reading distance: 24 cases divergent. Squint in both distances was only found in 6 cases, which had scotomas of a very large extent (Figure 2).

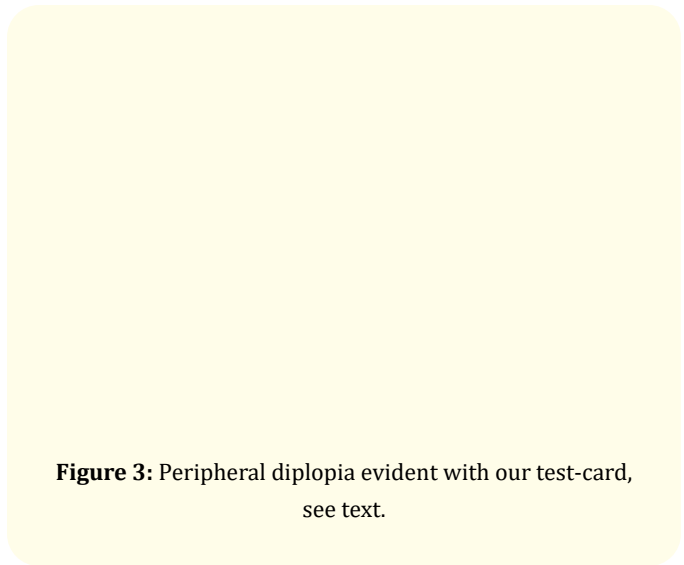
Figure 2: Absolute scotoma, squint. Reprint with kind permission of Nova Science Publishers.

**Discussion of the results**

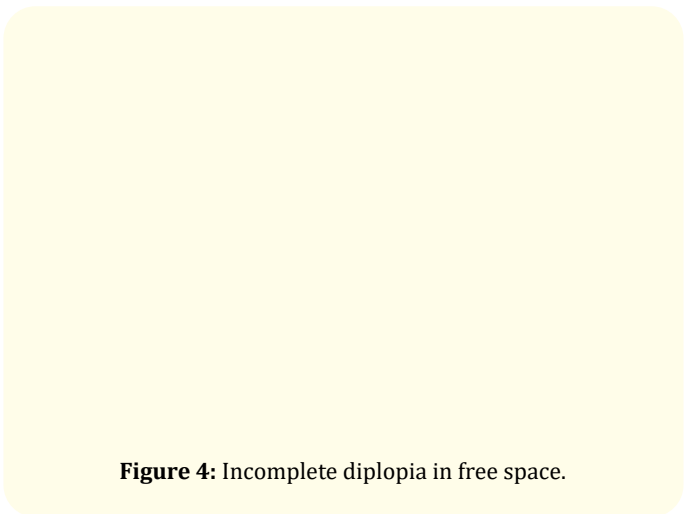
As anticipated, the larger the visual field defects were, the more patients squinted except that the scotomas were incomplete and sievelike. The only type of squint which the patients showed in reading distance was divergence. When fixing distant objects, most patients were also divergent. The 4 exceptional cases showing convergent eye position for distance we explain to be "age-related distance esotropia", a sort of senile squint incidentally combined with age-related maculopathy. The other 10 distance divergent cases had extent and eccentric visual field defects in the periphery. Contrarily, defects afflicting the retinal parts between 2° and 13° from the center seemed to be responsible for the loss of fusion and divergent squint in near distances; (see Figure 2).

**Subjective symptoms**

Typically, patients suffering from maculopathy at each visit demand the prescription of stronger glasses. They are not aware of their loss of binocularity; instead of reporting the typical double vision they declare to have blurred vision, to see clouds and often they close one eye to see better. These symptoms we have called "masked diplopia". Sometimes a patient reports seeing the frame of the TV screen double, but not the speaker in the centre of TV, this state is called "peripheral diplopia" (Figure 3), which indicates the degree of the squint deviation combined with a central scotoma of the damaged eye. These double pictures are always incomplete, only partially seen (Figure 4).



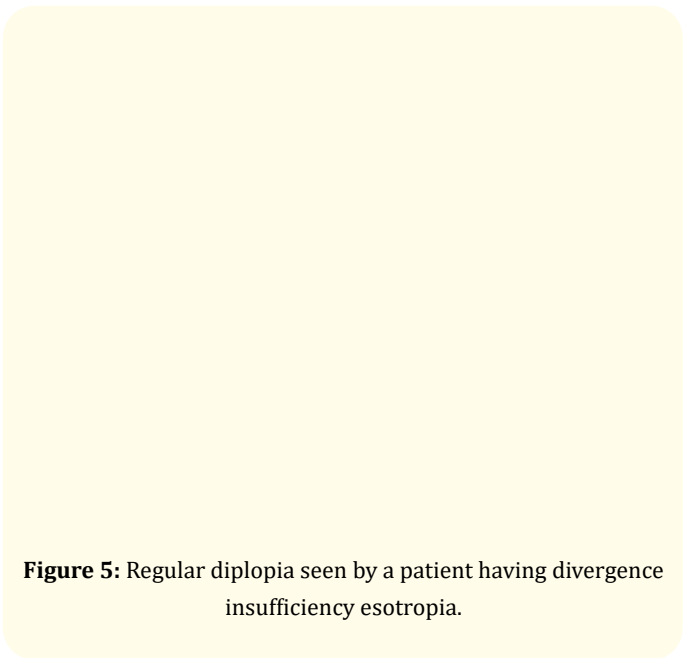
**Figure 3:** Peripheral diplopia evident with our test-card, see text.



**Figure 4:** Incomplete diplopia in free space.

**Differential diagnosis**

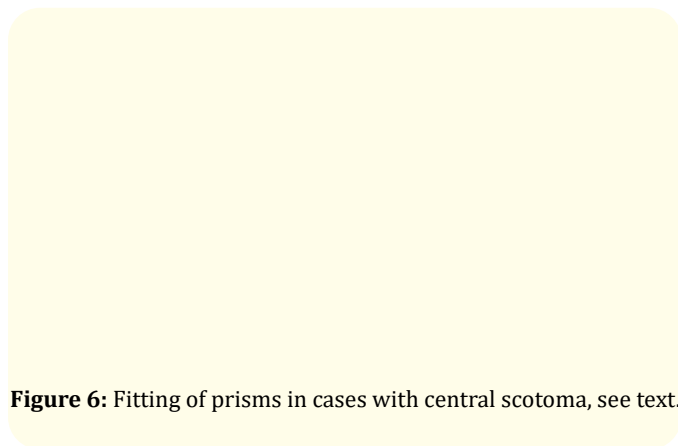
As mentioned above, elderly persons may suffer from "age related distance esotropia", former known as "esotropia of presbyopic age" or "divergence insufficiency esotropia". These patients see real objects totally doubled but only in the far distance (e.g. the actors at the theatre), while reading they have no problems (Figure 5) This sort of diplopia can easily be diagnosed by torch and red-glass; there is no central scotoma.



**Figure 5:** Regular diplopia seen by a patient having divergence insufficiency esotropia.

## Therapy

As diagnose is as difficult is the therapy, because of the indistinctly described symptoms. Individual patients seeing the TV screen with a double contour gave reason for a trial with a rectangular white cardboard, in its midst a fixation object; this card used in a dark room should provoke a double contour and could be used at varying distances.(see Figure 3) This trial setup proved to be effective to measure the eye-deviation using a horizontal and/or vertical prism bar which brings the double contour to cover the original line. A press-on prism of the measured prism value was applied to the spectacle-glass of the afflicted eye. We used a different possibility for fitting prisms to treat reading difficulties: First you have to find the individual reading-distance of the patient and make a fairly exact prism correction by Krinsky test; afterwards you check the eyes' position with a torch and the Bagolini glasses and correct the prism power until the patient sees a cross with central light defect belonging to the damaged eye (Figure 6). A press-on prism given to the glass of the worse eye is of high benefit for the reading ability of the fixing eye; the peripheral fusion becomes activated and stables the fine motility of the master eye. This therapy is effective, especially for cases with high visual difference between both eyes. Eyes having both deteriorated to the same degree show mostly no squint.



**Figure 6:** Fitting of prisms in cases with central scotoma, see text.

## Prognosis

So far, an effective therapy exists only for wet maculopathies, not for dry ones.. But age and organic degenerations are progressive. Thus, a positive outcome of prism therapy may be only transitory and the prisms would have to be changed even after a short time. Therefore ground-in prisms are only indicated exceptionally

and the patient should be informed about the uncertainty of the future development of his vision.

## Glaucoma and Double vision

Out of 901 glaucoma patients 6 had distant esotropia and only 4 of them complained of diplopia, the others only of "bad vision" despite their loss of binocularity (see masked diplopia). In analogy to chapter 5.2.6, these esotropic patients had two pathologies combined: Divergence insufficiency esotropia and glaucoma. The glaucoma per se causes double vision only in very rare cases. Contrary to age-related maculopathy the visual field defects of glaucoma are always complete und never sievelike.

## Visual field defects and binocularity

20 patients aged 50- 83 yrs with advanced glaucoma underwent an examination of their visual field (Comperter 750) and of their orthoptic state, carried out with all usual methods. The comparison between the patients showing only a modest loss of binocular qualities and the intensively disturbed group gives information about the loss of binocular qualities as manifested by the increasing loss of visual field. The "normal" group had in the central parts of binocular visual field absolute scotomas up to 10°eccentricity with loss of fusional power of 28.5%, the severe cases 54% (89% deterioration), for the isoptere 15° we found the rate 45% : 72% fusion loss ( 60% deterioration).

The binocular state of the worst group (6 patients) based on complete binasal scotomas showed exotropia in near distance, severe convergence insufficiency without diplopia, almost no fusion range and reduced stereo vision. These patients read monocularly and had a remarkable benefit by the prismatic correction of their angle of divergence.

## Absolute glaucoma and diplopia

A despaired patient called me up, stating "you must help me, my doctor does not believe me, I have double vision although my left eye is blind." Indeed, she had only light perception from the nasal side and the bulb had gone into a divergent position. A prism folia base in managed to delete the double contour.

## Results and Discussion

Our aim was to define the functional border between central and peripheral fusion. Although corresponding points and Panum's areas are spread all over both retinas, there is no certain limit, but both studies showed, that the most intense fusion power is located in the circular region from 2° up to 10°-12° from the fixation point.

Absolute scotomas in this region result in convergence insufficiency, divergent eye position and reading difficulties; defects of visual field located in the periphery lead to divergent squint. Incomplete or sievelike scotomas may have no consequences.

Two ophthalmological diseases characterized by progressive visual field defects have been compared relating to their binocular state and subjective symptoms. In both cases the difficulties start with the onset of squint. An extent central scotoma caused by maculopathy makes one eye deviate and see objects double but only partially according to the degree of squint. Even in almost blind eyes double contours may occur. But not every patient with deviated eyes sees double pictures, some complain only of blurred vision or grey clouds. In contrast the case of glaucoma: Diplopia happens at the time when the binasal visual defect reaches the center of one eye and divergence develops. Over the years before that, of course, the patients had suffered a slowly progressive loss of binocularly active areas in the visual field without distinct complaints, only reporting about bad eyesight, even with the right glasses.

### Conclusion

The ophthalmologists are recommended not only to treat the main pathology of a patient but also to take notice of the patient's verbal complaints which often are indistinct; e.g. The patient describes double pictures which cannot be certified with usual methods like red-glass. All complaints should be taken seriously and the possibility should be considered that a binocular problem may be the cause [1-3].

### Acknowledgements

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### Conflict of Interest

There is no conflict of interest.

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