Temporal processing deficits in the „intact“ visual field. Study of „sightblind“ in cortical and optic nerve lesion patients.

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Introduction

Based on detection abilities visual field (VF) of patients with visual system damage (Fig. 1) is typically divided into three areas: blind field, relative defect (area of residual vision, ARV) and intact field (Sabel et al., 2011, Fig. 2).

However, discovery of the blindsight phenomenon showed that there are residual visual capacities in the presumably „blind“ field (Weiskrantz et al., 1974), in the same time, hitherto unrecognized perceptual deficits exist in the „intact“ field (Paramei & Sabel, 2008, Poppel et al., 2011) - a phenomenon we term „sightblind“ (Bola et al., submitted). Concerning the neural mechanisms, network changes after visual cortex damage were proven to exist (Fig. 3) and together with local, intracortical interactions might mediate „sightblind“.

Present study was carried out with the aim to (I) check whether „sightblind“ occurs in patients with other than cortical loci of the lesion and (II) to elucidate factors associated with severity of the „sightblind“.

Methods

We tested age matched groups of hemianopia (n=121) and optic nerve patients (n=64) with high resolution perimetry (HRP). In this method supra-threshold stimuli are presented on a gray background in random locations. Based on detection accuracy visual field was divided into blind (acc.<0.2; black), residual vision (0.2>acc.<0.8; gray) and intact area (acc.>0.8; white) (Fig. 2). We analysed reaction time (RT) upon detection of the perimetry stimuli, with the special emphasis on the intact VF.

Results

Firstly, RT is related to the functional state of a given VF area (p<0.001, Fig. 4). Significantly higher RT was observed in the optic nerve patinets intact VF then in hemianopia patinets intact VF (p=0.016).

Secondly, we investigated topography of the intact VF deficit (Fig. 5). Intact VF sectors lying in the vicinity of the scotoma have significantly increased RT in comparison to sectors far from the „blind“ area (p<0.001).

Thirdly, more severe intact VF deficit is associated with bigger scotoma (Fig. 6). This relationship was found for both, optic nerve (r=0.58, p<0.001) and hemianopia group (r=0.44, p<0.001).

Additionally, on a subgroup of quadrantanopia patinets (n=12) we show that degree of the intact VF deficit depends on the position of the tesed quadrant relative to the scotoma (Fig. 7).

Conclusions

In the present study we investigated „sightblind“ phenomenon in patinets with differen loci of the visual system lesion. While earlier experiments proved presence of perceptual deficits in the „intact“ VF of cortically lesioned patinets, here we showed that „sightblind“ occurs also after optic nerve damage.

Further, in both groups we found that I) scotoma proximity accounts for within-subject variability and topography of the intact VF deficit, while II) size of the scotoma explains between-subject variability. We conclude that both, local interactions within the lesioned or deafferented cortex, as well as indirect modifications of the visual networks contribute to the sightblind effect (Fig. 8).

References