The Anatomico-Functional Behaviour of Foveomacular Retinoschisis

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Introduction

Foveomacular retinoschisis (FRS) describes the lamellar splitting of the neurosensory retina in the central macular. This feature can occur as part of a complex pathophysiological process, as in congenital X-linked retinoschisis (XLRS)), or as an isolated mechanical phenomenon in various acquired conditions (e.g. myopic traction maculopathy (MTM), optic disc pit maculopathy (ODP-M) or idiopathic foveomacular retinoschisis (IFR)).[1-3]

Subjects with FRS and intra-retinal fluid (IRF) tend to retain good visual acuity, in the absence of development of foveal detachment or macular hole.[1,2]

This study implements a deep learning approach to segment OCT scans and observe associations between IRF distribution and microperimetric macular function in FRS.

Methods

Subjects with both acquired and congenital FRS were included. 250 B-scan OCT slices (Cirrus 5000, Carl Zeiss Meditec) were manually annotated by two ophthalmologists. Intra- and inter-observer comparison was made for 10 annotations.

A fully convolutional neural network, with an 'encoder-decoder' architecture, was trained to segment IRF (figure 1).

Automatically-segmented 3D fluid maps were registered to subjects' microperimetry sensitivity maps (MAIA, CenterVue), to evaluate corresponding point-wise macular sensitivity (figure 2).

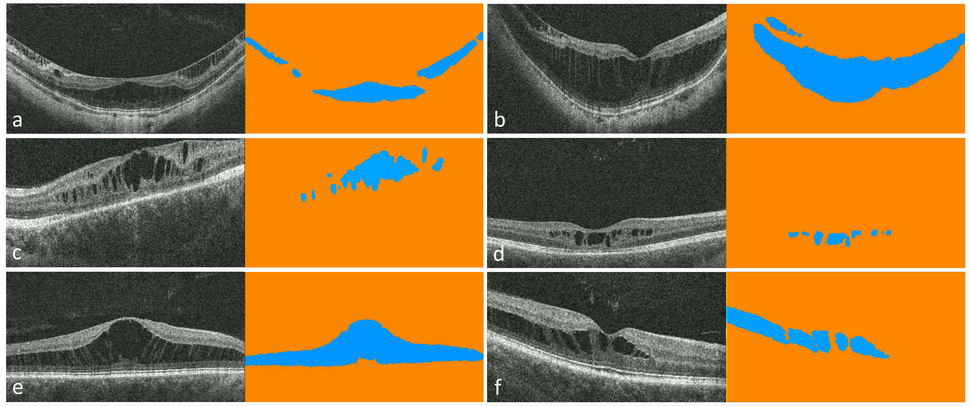


Figure 1: Examples of automated segmentation results for IRF in MTM (a&b), XLRS (c&d), ODP-M (e) and IFR (f)

Table 1: Macular sensitivity according to presence/absence of IRF

Pathology	Eyes	MS if no IRF (dB)	MS if IRF (dB)	*p-value*
MTM	10	26.6 ±2.3	26.0 ±2.1	*<0.001*
ODP-M	4	28.0 ±2.1	26.0 ±3.1	*<0.001*
IFR	9	29.2 ±1.5	28.4 ±1.9	*<0.001*
XLRS	9	26.4 ±3.0	23.8 ±4.0	*<0.001*

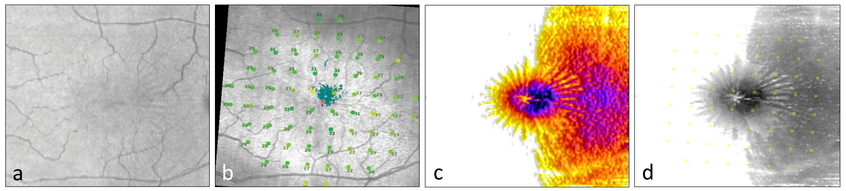


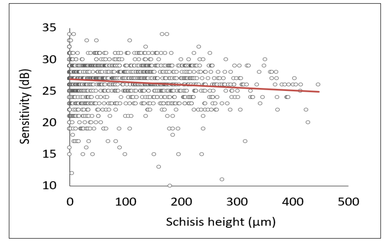
Figure 2: Image registration of near infrared image (a) to microperimetry map (b); en face automated segmentation of IRF (c) and with microperimetry overlay (d)

Results

Data from 32 eyes with FRS were included in the final analysis (table 1). We used a '9-fold leave-one-out' cross validation to obtain a mean Dice score of 86%, representing good IRF and segmentation performance of our model relative to a human observer.

The presence of IRF in acquired FRS was associated with slightly worse average point-wise MS, compared to areas with no fluid (26.9dB vs 27.9dB, $p<0.001$). IRF in congenital FRS was significantly associated with worse MS (23.8dB) than both acquired FRS and areas with no fluid (both $p<0.001$).

Point-wise sensitivity over the areas with IRF in acquired FRS was significantly associated with the schisis cavity height (μm) ($p<0.001$, $\beta=-0.007$, graph 1).



Graph 1: Relationship between schisis height and macular sensitivity

Conclusion

The presence of IRF appears to have a small, but significant, association with worse microperimetric sensitivity in cases of acquired FRS, and a stronger association in congenital FRS. There is a linear association between schisis cavity height and sensitivity, although the effect size is small.

In spite of the above findings, eyes with acquired FRS are capable of retaining very good macular sensitivity, even in the context of marked retinal deformation.

References:

1. Shimada et al. Natural course of myopic traction maculopathy an factors associated with progression or resolution. Am J Ophthalmol. 2013
2. Bloch et al. Optic disc pit maculopathy: New perspectives on the natural history. Am J Ophthalmol. 2019
3. Ober et al. Stellate nonhereditary idiopathic foveomacular retinoschisis. Ophthalmology. 2010

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