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Application of Deep Learning for automated Detection of Macular Diseases and Abnormalities of vitreomacular Interface.

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Disclosure Statement of Financial Interest

Anna A. Ledolter is an employee of the Digital Vision Solutions LLC and received a part-time salary for this work
Alexander Yu. Sizov is an employee of the Digital Vision Solutions LLC and received a part-time salary for this work
Evgenia A. Katalevskaya is an employee of the Digital Vision Solutions LLC and received a part-time salary for this work

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Purpose

To develop an automated segmentation algorithm for the detection:

Cystoid macular edema (CME)

Central serous chorioretinopathy (CSR)

Age- related macular degeneration (AMD)

- Retinal drusen
- Macular Neovascularisation

Vitreomacular interface abnormalities (VMA)

- Full-Thickness macular hole
- Lamelar macular hole
- Vitreomacular Traction
- Epiretinal membrane

Methods

Materials:

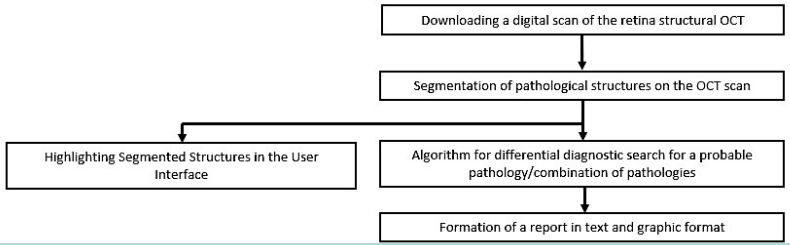
Training dataset 14000 OCTs; testing dataset 1000 OCTs

Artificial neural network model:

Feature Pyramid Network (FPN), EfficientNetB0, CenterNet

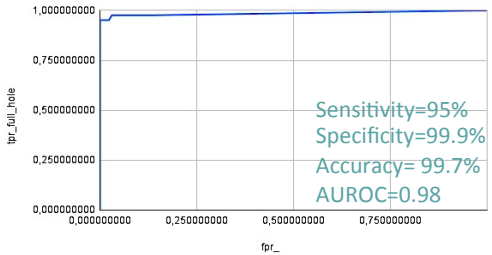
Following pathological signs were segmented:

intraretinal (IRF)&subretinal (SRF) fluid, retinal pigment epithelial detachment (PED), subretinal hyperreflective material (SHRM), retinal drusen (RD), epiretinal membrane (ERM), vitreomacular traction (VMT), lamelar (LMH)&full-thickness (FTMH) macular hole.

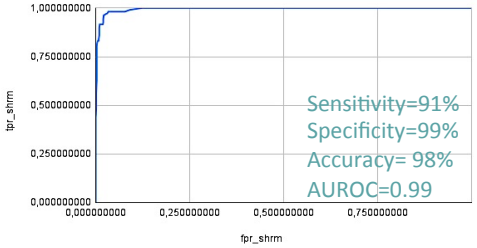


Results: Estimation of accuracy parameters of the algorithm on the validation database

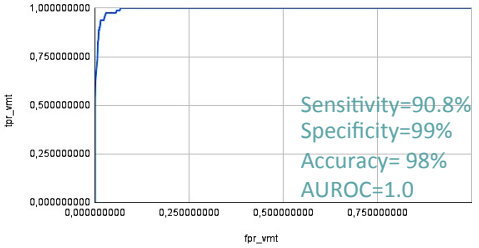
ROC AUC Full thickness macular hole



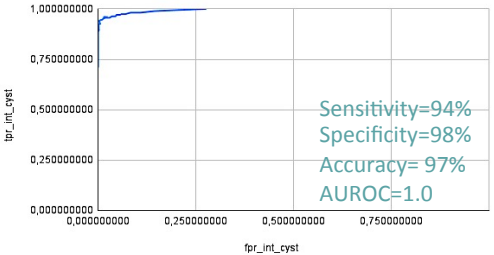
ROC AUC SHRM



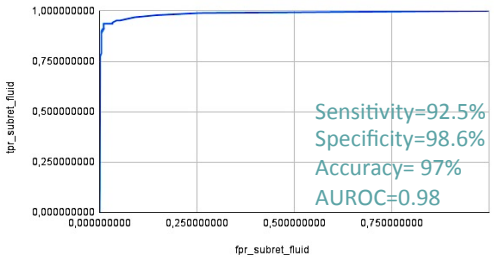
ROC AUC Vitreomacular traction



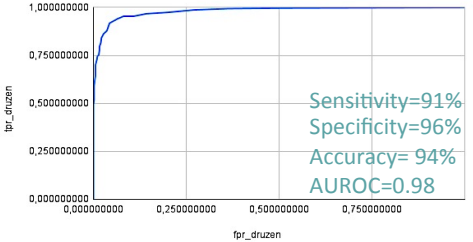
ROC AUC Intraretinal cysts



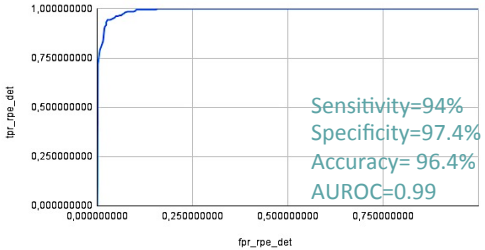
ROC AUC Subretinal fluid



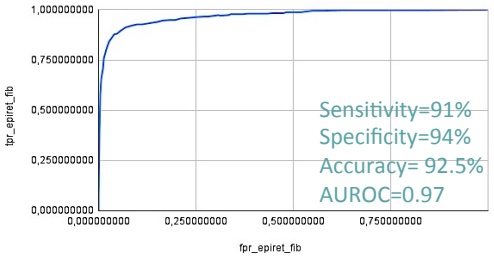
ROC AUC Retinal drusen



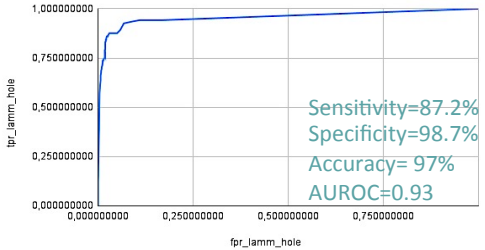
ROC AUC RPE detachment



ROC AUC Epiretinal membrane



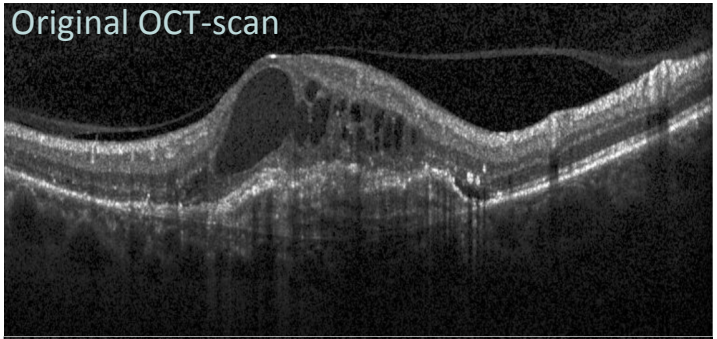
ROC AUC Lamellar macular hole

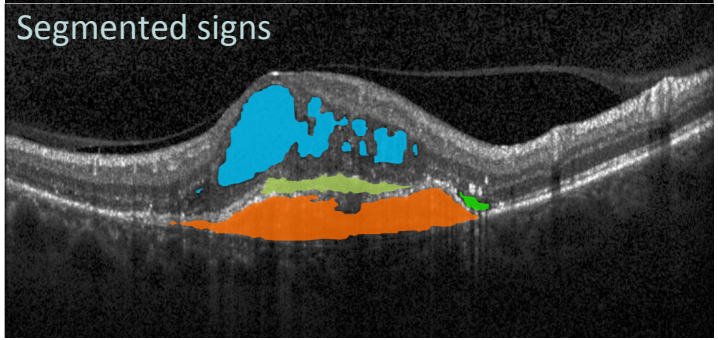


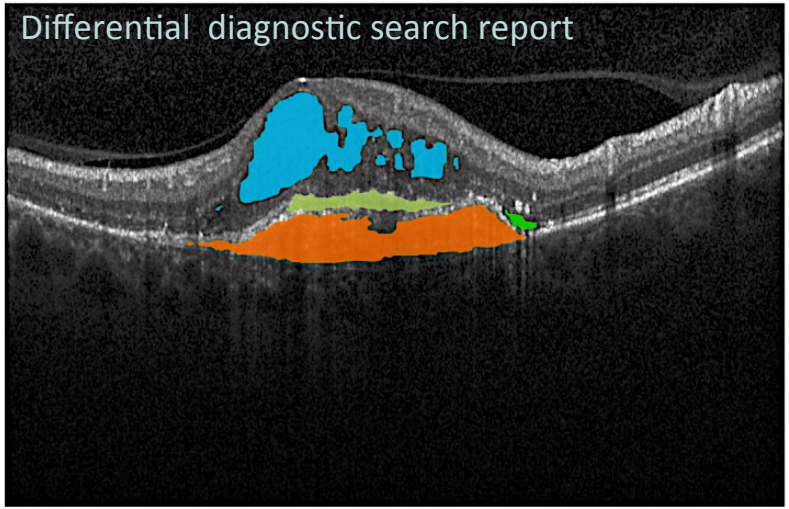
ROC curves and AUCs for each of segmented pathological sign

Results: Example of segmentation and reporting by pathology.

Macular Neovascularisation







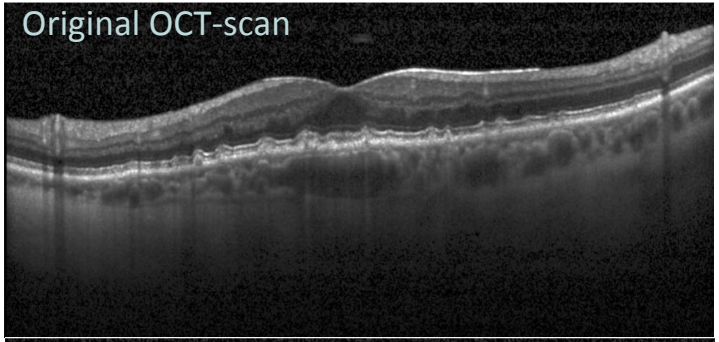
	Detection
Intraretinal Cysts	Detected
Subretinal Fluid	Detected
Retinal Pigment Epithelium Detachment	Detected
Subretinal Hyper-Reflective Material	Detected
Retinal Drusen	Not detected
Epiretinal Membrane	Not detected
Full Thickness Macular Hole	Not detected
Lamellar Macular Hole	Not detected
Vitreomacular traction	Not detected

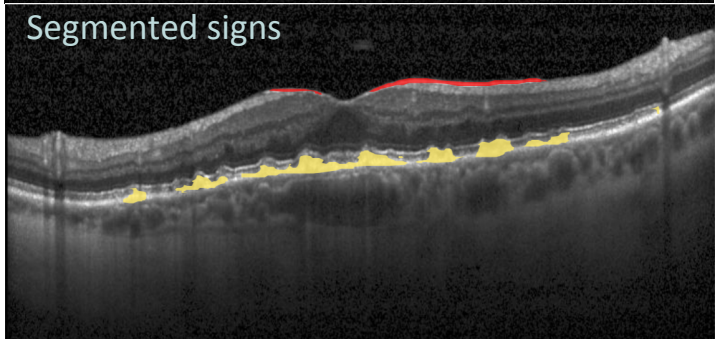
Differential Diagnosis*

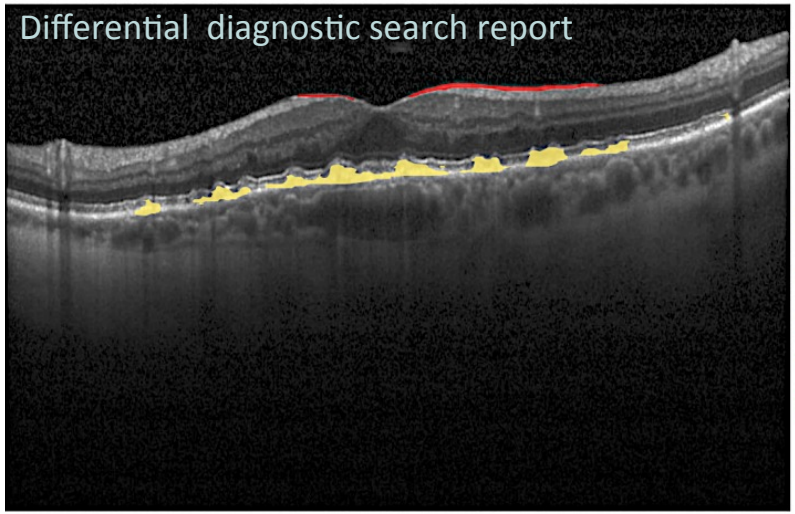
Features	Possible Pathology							
	Cystoid Macular Edema/Diabetic Macular Edema	Age-related Macular Degeneration (Dry Form - Retinal Drusen)	Macular Neovascularization	Epiretinal Membrane	Central Serous Chorioretinopathy	Full Thickness Macular Hole	Lamellar Macular Hole	Vitreomacular traction

Results: Example of segmentation and reporting by pathology.

Age-related Macular Degeneration/ Epiretinal Membrane







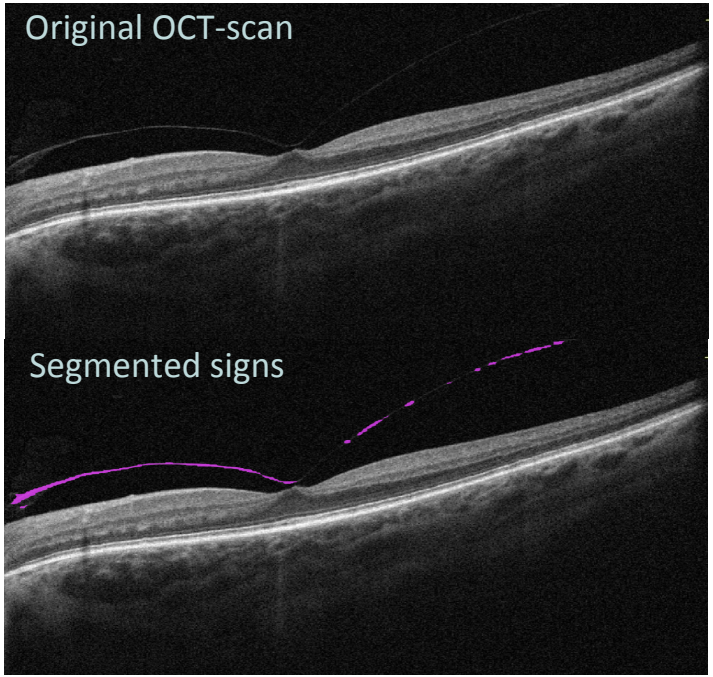
	Detection
Intraretinal Cysts	Not detected
Subretinal Fluid	Not detected
Retinal Pigment Epithelium Detachment	Not detected
Subretinal Hyper-Reflective Material	Not detected
Retinal Drusen	Detected
Epiretinal Membrane	Detected
Full Thickness Macular Hole	Not detected
Lamellar Macular Hole	Not detected
Vitreomacular traction	Not detected

Differential Diagnosis*

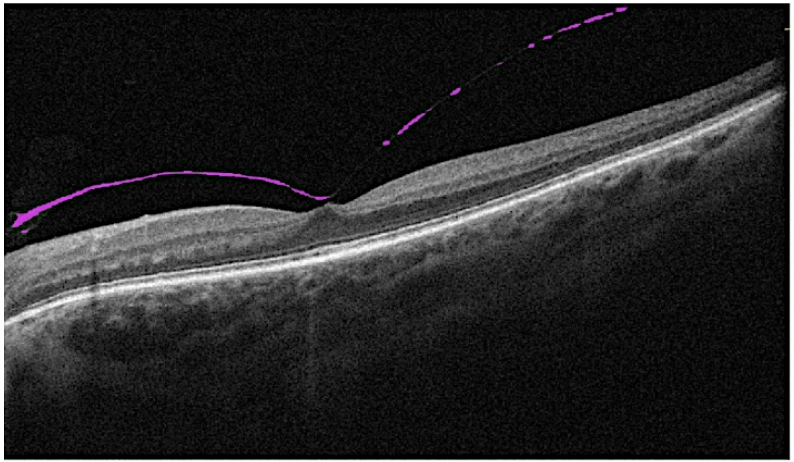
Features	Possible Pathology							
	Cystoid Macular Edema/Diabetic Macular Edema	Age-related Macular Degeneration (Dry Form - Retinal Drusen)	Macular Neovascularization	Epiretinal Membrane	Central Serous Chorioretinopathy	Full Thickness Macular Hole	Lamellar Macular Hole	Vitreomacular traction

Results: Example of segmentation and reporting by pathology.

Vitreomacular Traction



Differential diagnostic search report



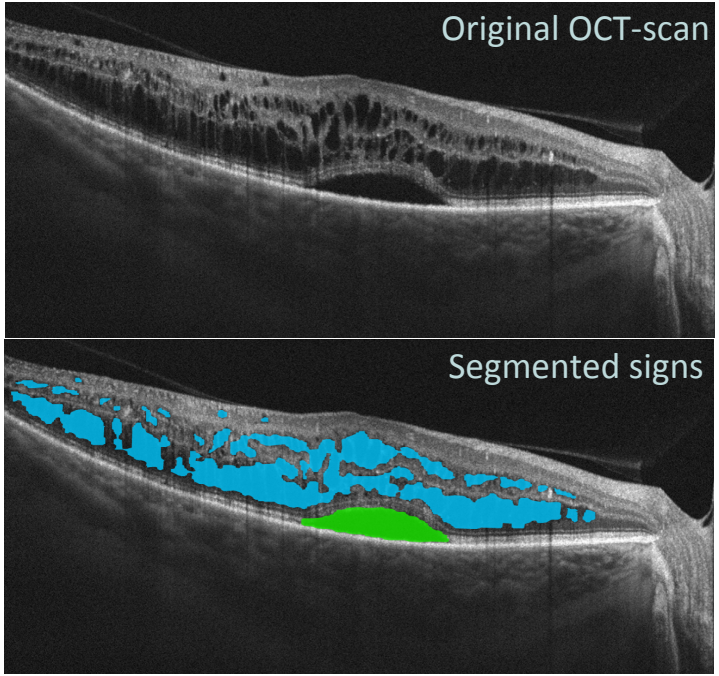
	Detection
Intraretinal Cysts	Not detected
Subretinal Fluid	Not detected
Retinal Pigment Epithelium Detachment	Not detected
Subretinal Hyper-Reflective Material	Not detected
Retinal Drusen	Not detected
Epiretinal Membrane	Not detected
Full Thickness Macular Hole	Not detected
Lamellar Macular Hole	Not detected
Vitreomacular traction	Detected

Differential Diagnosis*

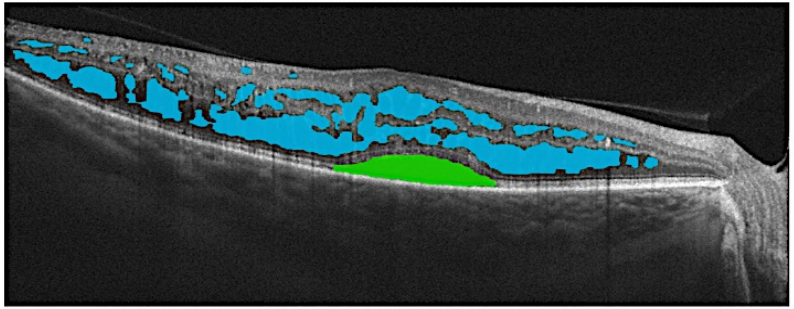
	Possible Pathology							
Features	Cystoid Macular Edema/Diabetic Macular Edema	Age-related Macular Degeneration (Dry Form - Retinal Drusen)	Macular Neovascularization	Epiretinal Membrane	Central Serous Chorioretinopathy	Full Thickness Macular Hole	Lamellar Macular Hole	Vitreomacular traction

Results: Example of segmentation and reporting by pathology.

Cystoid Macular Edema/Diabetic Macular Edema



Differential diagnostic search report



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Full Thickness Macular Hole	Not detected
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Differential Diagnosis*

Features	Possible Pathology							
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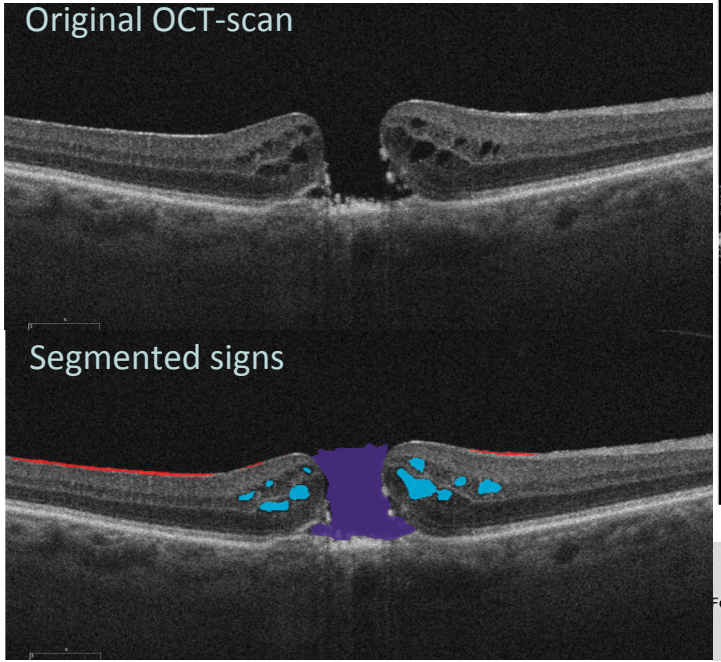
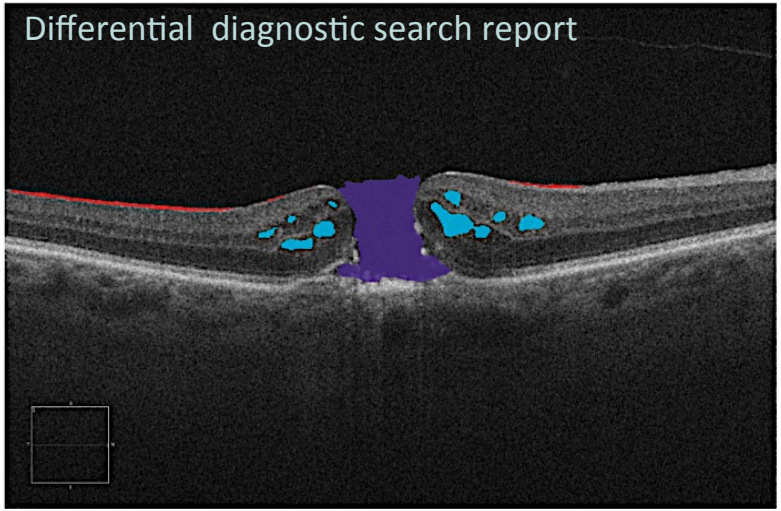
Results: Example of segmentation and reporting by pathology.

Full-Thickness Macular Hole/ Epiretinal Membrane





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Differential Diagnosis*

Features	Possible Pathology							
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Conclusion

The highly accurate algorithm of automated segmentation of retinal pathological signs was developed. Based on the designed segmentation algorithm we developed a differential diagnosis algorithm for detection of CME, AMD, VMA and CSR, which is currently approbed in a clinical trial.

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Preliminary data from clinical trials (n=200)

Diagnosis	Sensitivity (%)	Specificity (%)	Accuracy (%)
Diabetic macular edema/ cystoid macular edema (DME/CME)	96,08	97,48	97,14
Macular Neovascularisation (MNV)	97,50	97,65	97,62
AMD: retinal drusen	97,37	96,51	96,67
Central serous chorioretinopathy (CSR)	92,59	98,36	97,62
Vitreomacular Traction (VMT)	86,96	97,33	96,19
Full-Thickness macular hole (FTMH)	95,65	98,40	98,10
Epiretinal membrane (ERM)	100,00	97,12	98,10
Lamelar macular hole (LMH)	95,83	97,85	97,62
No pathological signs	94,72	97,69	97,25