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Fully automated Deep Learning analysis of hemoglobin images of the optic nerve associated with perimetry for the study of glaucoma

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Abstract

Purpose : Colorimetric analysis of optic nerve images for assessing their hemoglobin distribution (Laguna ONhE) (1-4) is tested in combination with perimetry.

Methods : Deep learning training was used to identify nerve edges, laterality of the eye, image quality, vessel segmentation and classification (normal vs glaucoma). Data was compiled into a "Globin Distribution Function" (GDF), which was also associated with visual field irregularity indices: Pattern Standard Deviation (PSD), square root of loss variance (sLV), and threshold coefficient of variation (TCV) (5).
477 normal eyes and 333 confirmed and suspected glaucoma eyes, which were examined with three fundus cameras, two perimeters and two visual field strategies. The results were compared with Cirrus OCT.

Results : GDF sensitivity identifying glaucoma was 75.7% for a specificity of 99.0%. The most sensitive OCT index was the Rim Area (sensitivity 67.0%, P=0.0131). Its association with visual field irregularity produced the following AUC's: GDF&PSD-sLV = 0.963-0.986 and GDF&TCV = 0.965-0.987, while Rim Area&PSD = 0.927-0.960, Vertical Cup/Disc&PSD = 0.929-0.961 and RNFLT&PSD = 0.894-0.933 (P<0.0001 in all cases). For 99% specificity, GDF&TCV achieved 80.8% sensitivity and RNFLT&PSD 72.4%.

In cases where the morphological or functional indices had an unusual level in regard to 95% of normal subjects, the GDF&TCV achieved AUC's of 0.99-1.00 and sensitivities of 87.3-96.0% for 99% specificity.

Conclusions : Laguna ONhE associated to perimetry offers relevant diagnostic results in glaucoma, although new studies might be necessary to consolidate such results.

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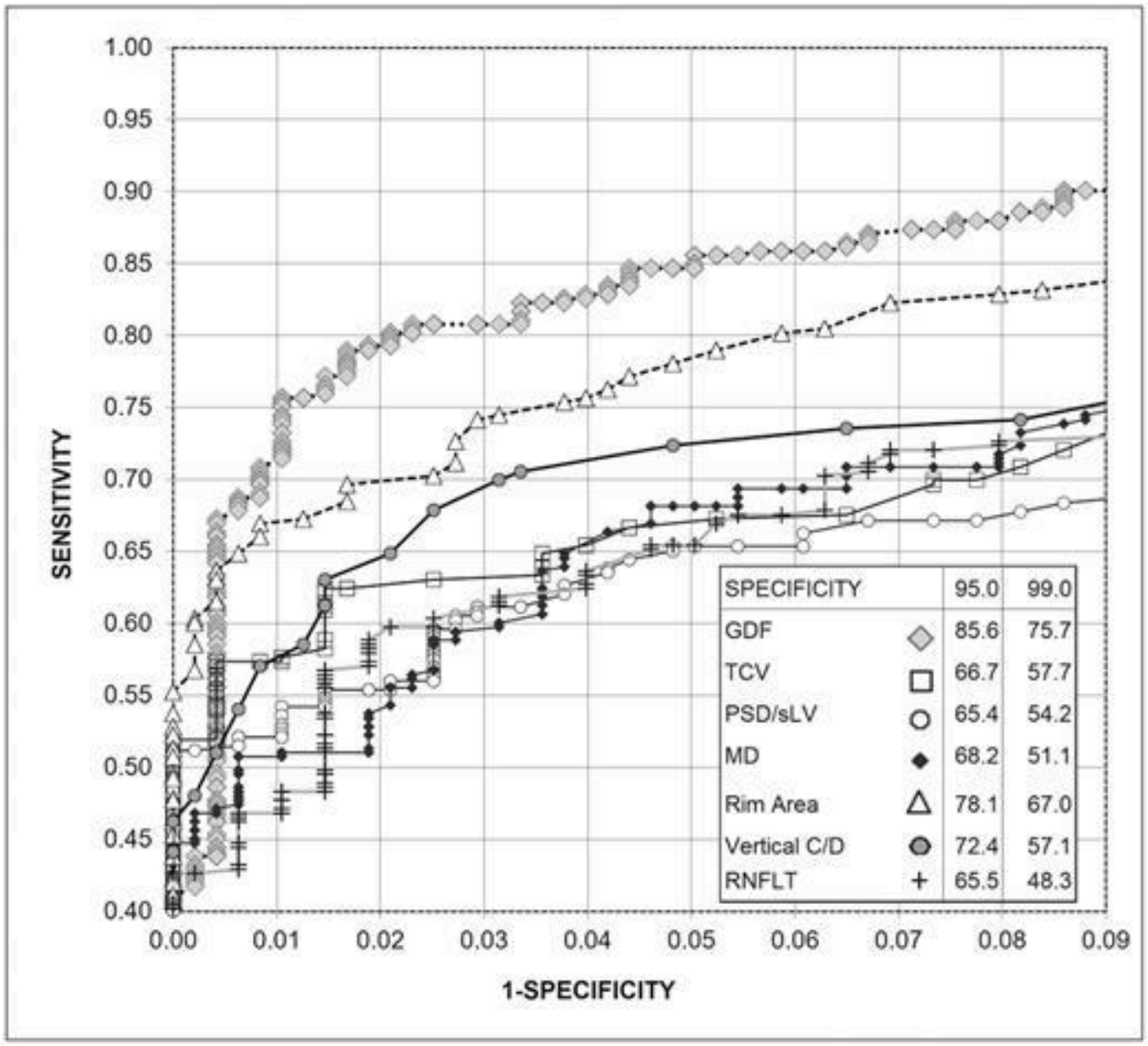

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Fig. 1. ROC curves obtained with Laguna ONhE, OCT-Cirrus and perimetry indices and sensitivities for 95%-99% specificities.

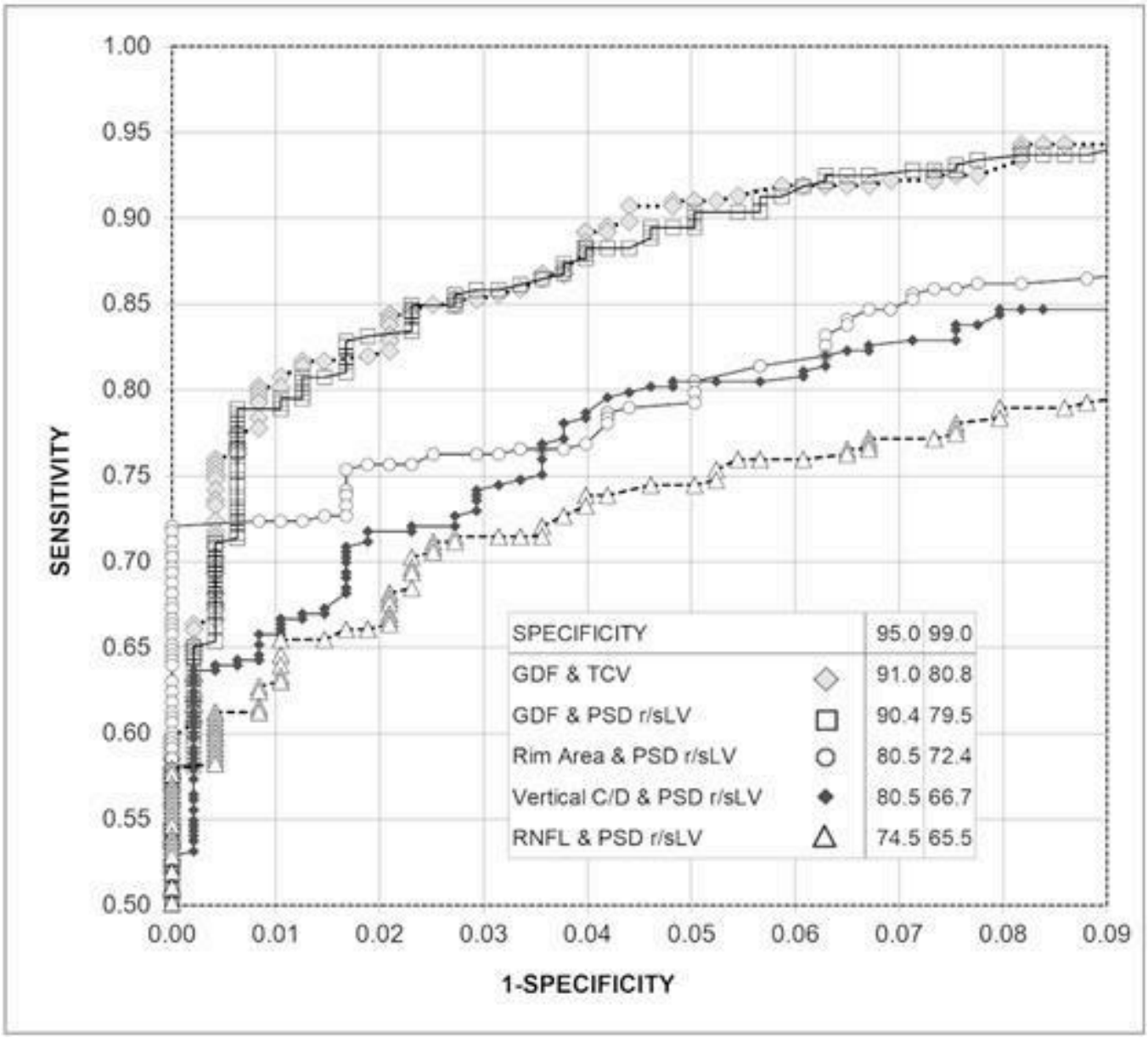

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Fig.2. ROC curves of the combinations between Laguna ONhE and OCT-Cirrus with perimetry.

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