Probability of Glaucoma Determined from Standard Automated Perimetry and from Optic Disk Topography using Relevance Vector Machine Classifiers

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Abstract

Purpose: To evaluate relevance vector machine (RVM) as a machine learning classifier for detecting glaucoma from standard automated perimetry (SAP) and from Heidelberg Retina Tomograph (HRT) optic disk topographic measurements. The advantages of RVM over support vector machines are optimized learning and the availability of the probability of a diagnosis.

Methods: For evaluation of SAP using RVM, we compared normal eyes (n=189) to glaucoma eyes (n=156). Glaucoma was defined as the presence of glaucomatous optic neurapthy based on evaluation of stereophotographs. The inputs for the RVMs were 52 visual field locations from SAP plus age. For evaluation of HRT optic disk topography using RVM, we compared normal eyes (n=135) to glaucoma eyes (n=95). Glaucoma was defined as repeatable SAP visual field damage. The inputs were 22 global, 84 regional, and 72 sectoral topographic optic disk parameters. Cross validation was used in all training to present to the trained RVMs cases not previously seen by the RVMs.

Results: For SAP, the area (±SD) under the receiver operating characteristic (ROC) curve using RVM was 0.916±0.016. The sensitivity was 76% at a fixed specificity of 90%. For HRT optic disk topography, the area (±SD) under the ROC curve using RVM was 0.939±0.016, and the sensitivity was 83% at a fixed specificity of 90%. For each of the test groups, the mean (±SD) probability of disease in the glaucoma group was significantly higher than the normal group, for SAP: 0.77±0.31 and 0.18±0.21, respectively, and for HRT topography: 0.80±0.31 and 0.13±0.20, respectively.

Conclusions: RVMs performed at the level of the best previously reported machine learning classifiers, including support vector machines and mixture of Gaussian. Compared to these classifiers, RVM has the advantage of providing the probability of diagnosis, which can be used by the clinican in conjunction with risk factor and other diagnostic test information to determine the individual patient's likelihood of having glaucoma.

Keywords: perimetry • topography • computational modeling