Fully-automated Screening for Age-related Macular Degeneration using Advanced Image Analysis

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Study Group:

ABSTRACT

ABSTRACT BODY:

Purpose: Age-related macular degeneration (AMD) is the single largest cause for legal blindness among senior Americans. Non-neovascular or dry (atrophic) AMD is the primary form of AMD contributing to 85% of the AMD cases and may be asymptomatic or result in a gradual vision loss. A robust screening test for AMD that can be performed by a primary health care provider or an optometrist, who can then refer the patient to an eye specialist, will be a useful first step in casting a wider net and helping reduce the toll of severe vision loss with timely intervention and patient education. To this end, we present an automated AMD screening system based on novel drusen identification and quantification from color fundus images.

Methods: 3340 color retinal fundus images from 338 elderly adults obtained by an AMD screening setup were used for this study. These images were graded on Age-Related Eye Disease Study (AREDS) grade by experts at Doheny Eye Institute (DEI). Cases with no AMD or early AMD were deemed as non-referable.

We use robust low-level image processing combined with powerful statistical inference to analyze these color fundus images for various AMD pathologies such as drusen. Our novel image analysis framework involves image enhancement, interest region detection, pixel and blob level description, and screening classification.

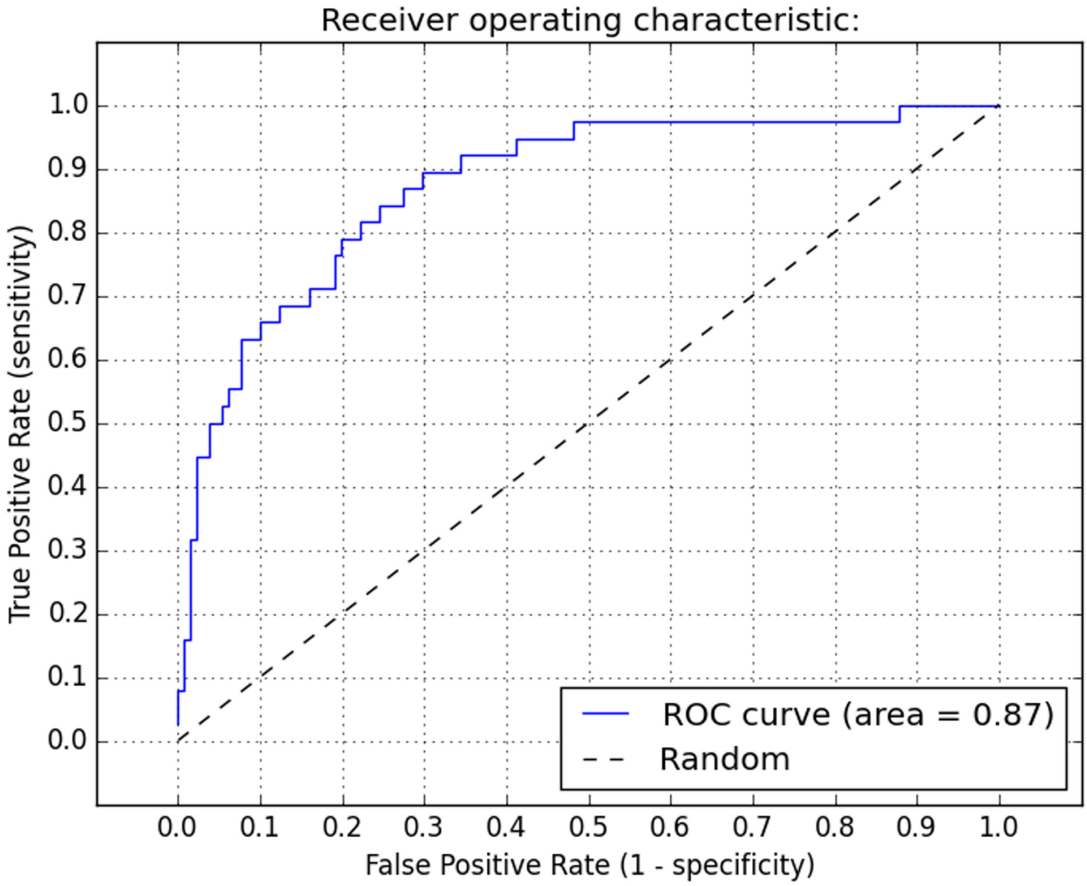
The dataset was randomly split into two parts with equal number of cases (50-50 split with 169 cases in each split), with one part used to train the screening classifier and other used to evaluate the classifier. We evaluated the performance of the automated system over multiple such random 50-50 test-train splits.

Results: The distribution of the AMD severity is shown in Fig. 1. We achieve average AUROC (Area under receiver operating characteristics curve) of 0.87 across 40 random 50-50 splits in determining refer AMD cases. On an example 50-50 split with AUROC close to average AUROC of 0.87 (Fig. 2), sensitivity of 90% was achieved with specificity of 70%.

Conclusions: We present a novel, automated approach for AMD screening that achieves an AUROC of 0.87 on the test dataset. Such an automated screening system can greatly aid in early detection and treatment of AMD.

AREDS Grade	Description	Refer/ No Refer	Number of patients
0	No drusen	No Refer	124
1	<20 hard drusen	No Refer	100
2	>20 hard drusen or some medium drusen	No Refer	44
3	>20 medium drusen, or a single large drusen	Refer	38
4	Foveal geographic atrophy in one eye	Refer	28
5	Choroidal Neovascularization (CNV) in one eye	Refer	4

Distribution of the 338 cases on AREDS grade



ROC plot for an example split with AUROC close to average AUROC.