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GLAUCOMA DIAGNOSTICS

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Please suggest recipes based on these ingredients...


Is AI Friend or Foe?

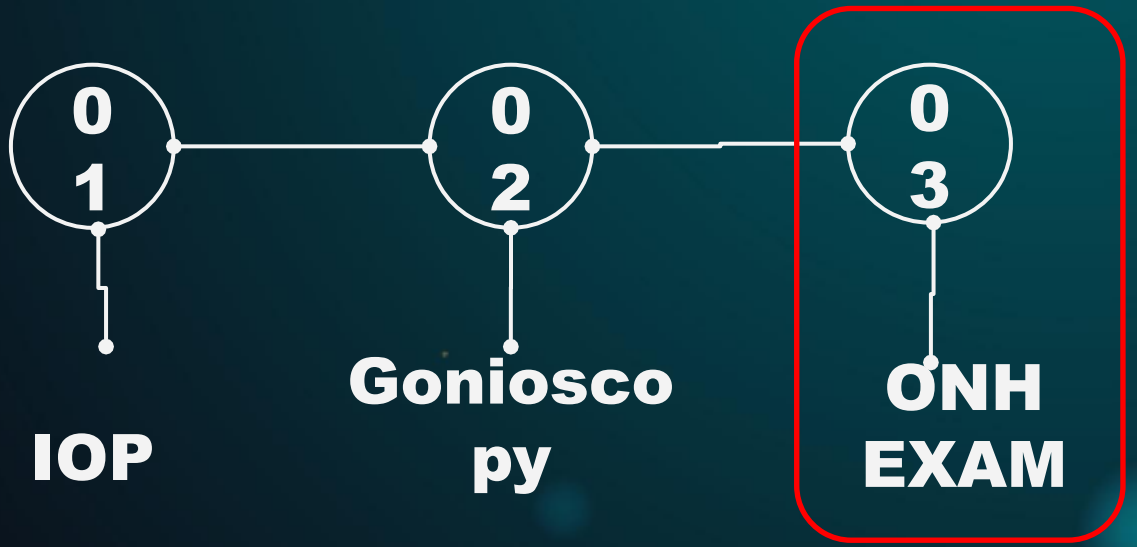
GLAUCOMA

- Affects over **90 million** individuals worldwide and it is a leading cause of blindness and subsequent disability.
- Glaucoma detection is challenging particularly at the early stages of the disease.
- Early detection may lead to slowing its progression and future vision loss.

How to make sure of glaucoma diagnosis??

- History
- Examination
- Investigations

EXAMINATION



DEFINITIONS

Development of computer systems able to perform tasks normally requiring human intelligence

The capacity of a computer to learn from experience

Machine learning algorithms whose neural network architecture uses many layers to progressively extract higher level features from the raw input

HOW CAN AI HELP IN GLAUCOMA?

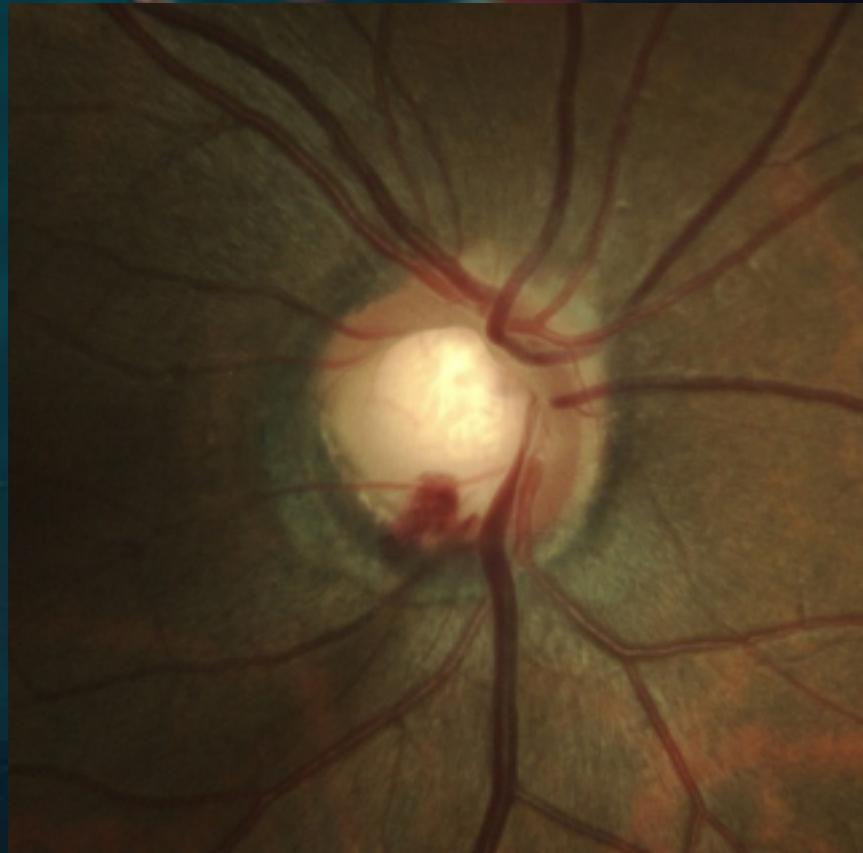
DIAGNOSIS

SCREENING

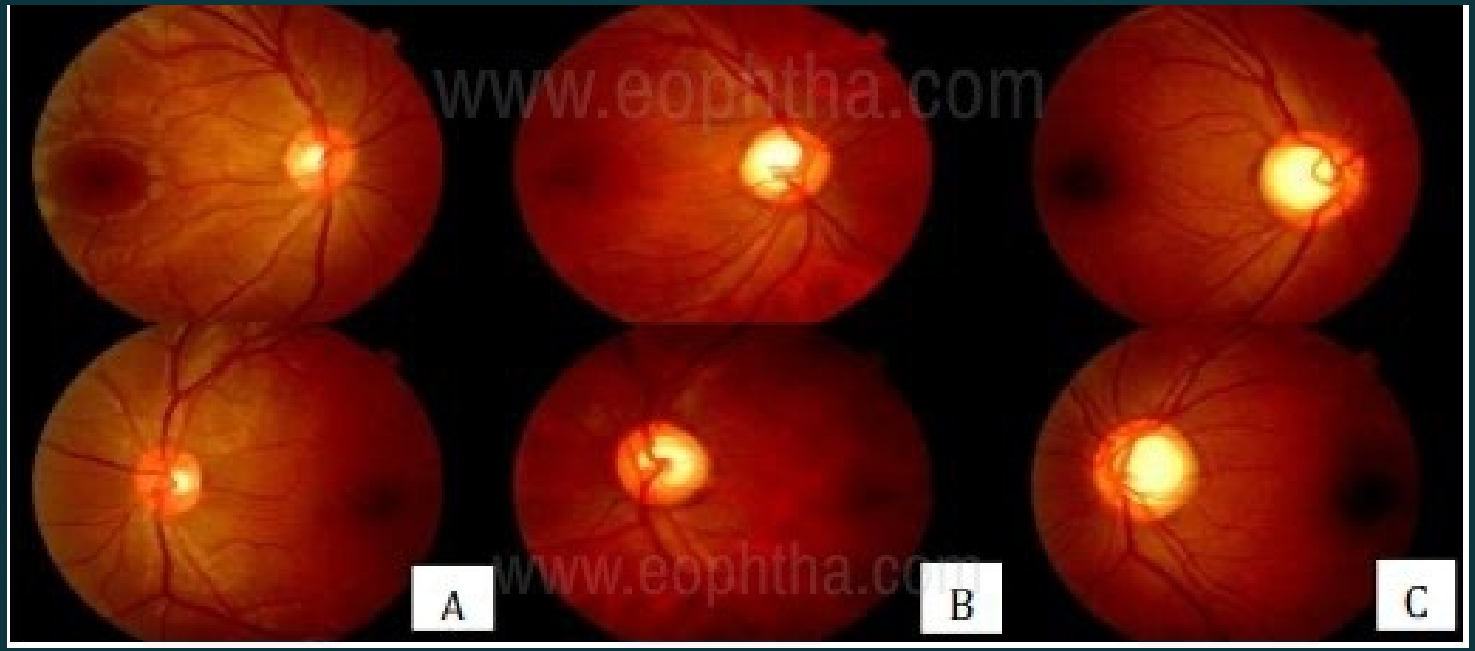
DETECT PROGRES

ONH

- Disc size
- Vertical C/D ratio
- Neuroretinal rim
- Peripapillary area
- NFLD
- Blood vessels at the disc
- Haemorrhage at the disc



Disc photography



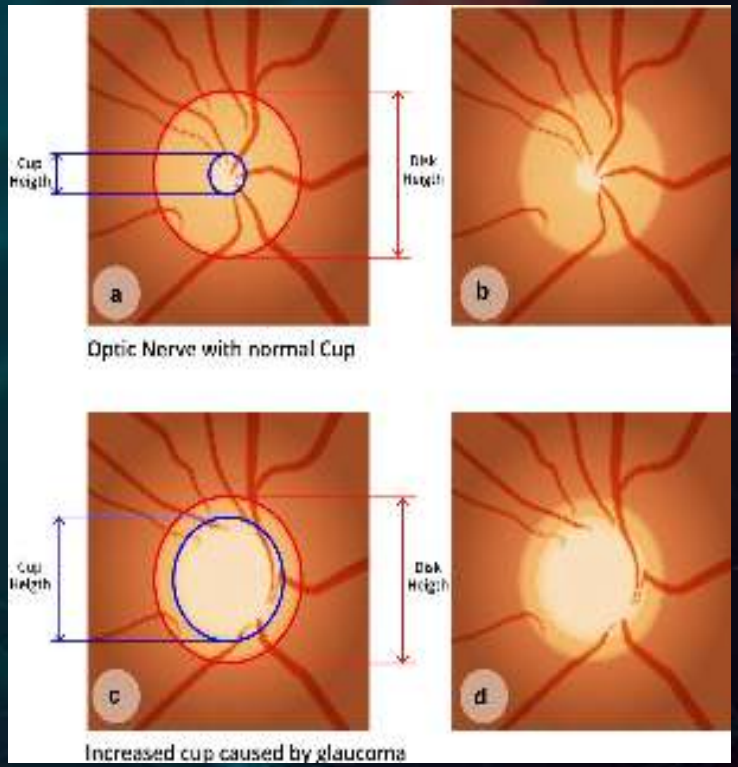
https://www.eophtha.com/posts/evaluation-of-the-optic-nerve-head-in-glaucoma#google_vignette

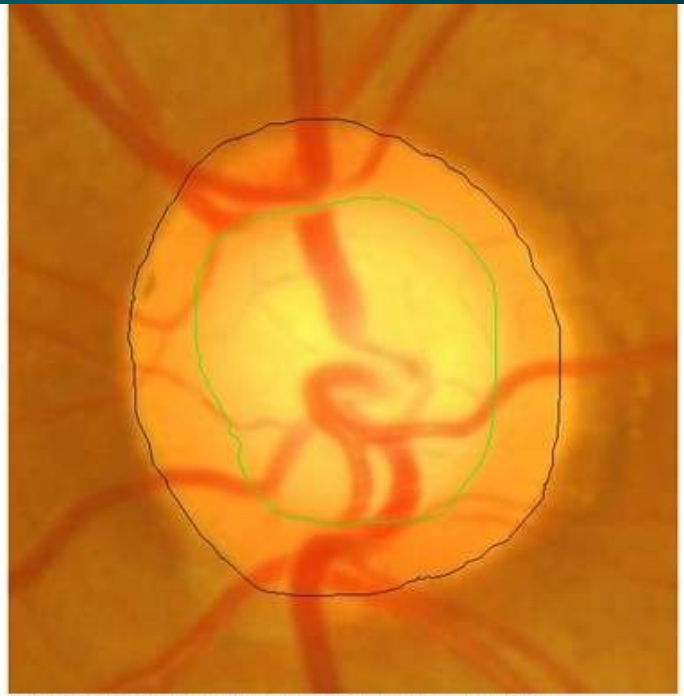
- Both ophthalmology trainees and comprehensive ophthalmologists underestimated the likelihood of glaucoma in **20%** of disc photographs.

- Ophthalmology trainees and comprehensive ophthalmologists were twice as likely to underestimate or overestimate the likelihood of glaucoma.

DISC PHOTOGRAPHY

- **Pegasus**: A deep learning system that detects glaucomatous optic neuropathy from color fundus photographs, available for use on the Orbis Cybersight Consult Platform.
- **Netra AI**: An AI system that evaluates glaucomatous fundus photographs.
- **Retinal Image Analysis – Glaucoma (RIA-G):** A cloud-based software that analyzes fundus images to detect glaucoma likelihood.





Size of this preview: 800 × 467 pixels. Other resolution: 1,000 × 584 pixels.

Original file (1,000 × 584 pixels, file size: 513 KB, MIME type: image/png)

Segmentation of Disc and Cup by Artificial Intelligence

Vertical CDR: **0.71**

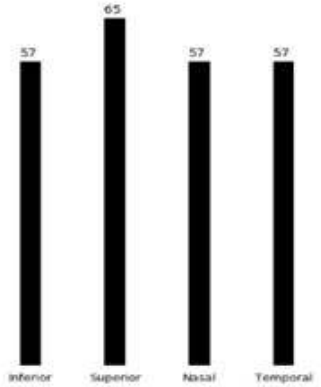
Horizontal CDR: **0.71**

DDLS Score: **0.114**

DDLS Stage: **4**

DDLS Condition: **At Risk**

ISNT :



RESULTS

NORMAL	Annual follow up
DISC SUSPECT	Referral suggested
GLAUCOMA	Urgent referral

Evaluation of an AI system for the automated detection of glaucoma from stereoscopic optic disc photographs: the European Optic Disc Assessment Study

Thomas W Rogers [1], Nicolas Jaccard [2], Francis Carbonaro [3], Hans G Lemij [4], Koenraad A Vermeer [4], Nicolaas J Reus [4 5], Sameer Trikha [2 6]

Affiliations + expand

PMID: 31267086 PMCID: PMC7002599 DOI: 10.1038/s41433-019-0510-3

Results: Pegasus was able to detect glaucomatous optic neuropathy with an accuracy of 83.4% (95% CI: 77.5-89.2). This is comparable to an average ophthalmologist accuracy of 80.5% (95% CI: 67.2-93.8) and average optometrist accuracy of 80% (95% CI: 67-88) on the same images. In addition, the AI system had an intra-observer agreement (Cohen's Kappa, κ) of 0.74 (95% CI: 0.63-0.85), compared with 0.70 (range: -0.13-1.00; 95% CI: 0.67-0.73) and 0.71 (range: 0.08-1.00) for ophthalmologists and optometrists, respectively. There was no statistically significant difference between the performance of the deep learning system and ophthalmologists or optometrists.

Ophthalmology. 2018 Aug;125(8):1199-1206. doi: 10.1016/j.ophtha.2018.01.023. Epub 2018 Mar 2.

Efficacy of a Deep Learning System for Detecting Glaucomatous Optic Neuropathy Based on Color Fundus Photographs

Zhixi Li [1], Yifan He [2], Stuart Keel [3], Wei Meng [2], Robert T Chang [4], Mingguang He [5]

Affiliations + expand

PMID: 29506863 DOI: 10.1016/j.ophtha.2018.01.023

Results: In the validation dataset, this deep learning system achieved an AUC of 0.986 with sensitivity of 95.6% and specificity of 92.0%. The most common reasons for false-negative grading (n = 87) were GON with coexisting eye conditions (n = 44 [50.6%]), including pathologic or high myopia (n = 37 [42.6%]), diabetic retinopathy (n = 4 [4.6%]), and age-related macular degeneration (n = 3 [3.4%]). The leading reason for false-positive results (n = 480) was having other eye conditions (n = 458 [95.4%]), mainly including physiologic cupping (n = 267 [55.6%]). Misclassification as false-positive results amidst a normal-appearing fundus occurred in only 22 eyes (4.6%).

Conclusions: A deep learning system can detect referable GON with high sensitivity and specificity. Coexistence of high or pathologic myopia is the most common cause resulting in false-negative results. Physiologic cupping and pathologic myopia were the most common reasons for false-positive results.

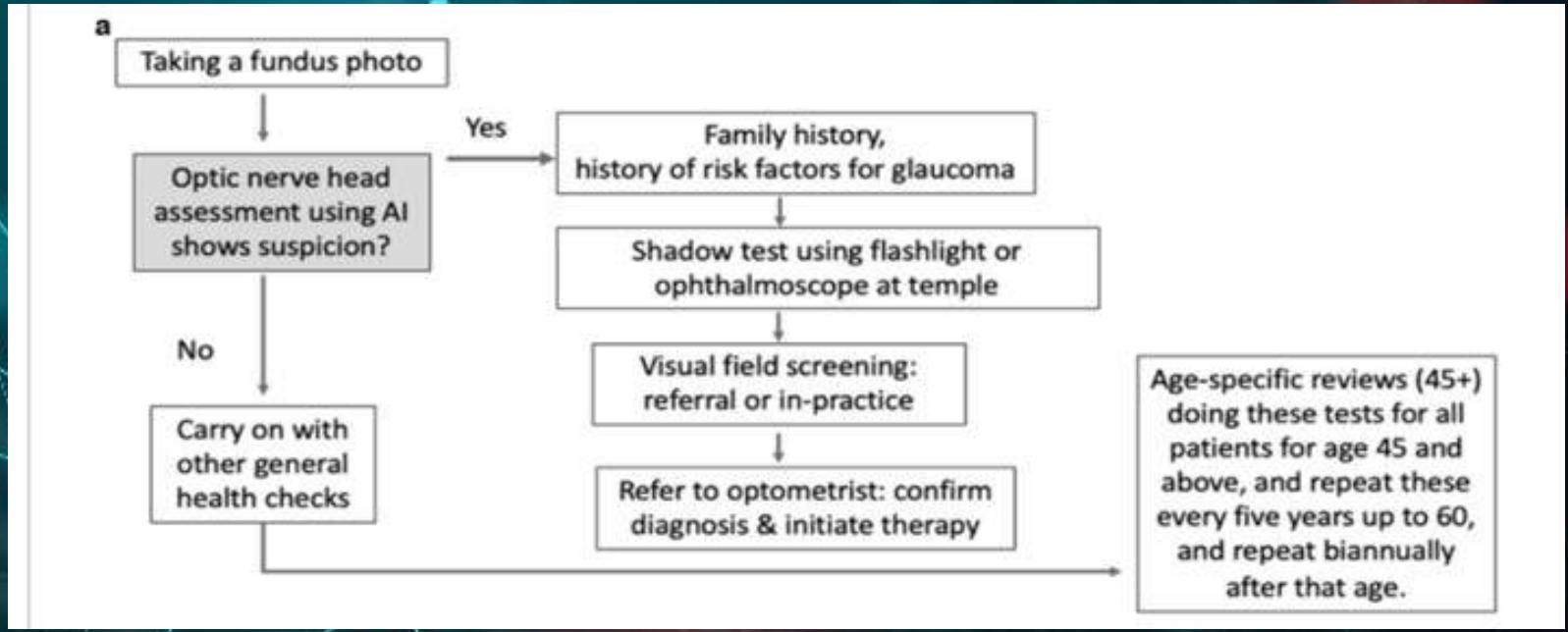
Applications

Diagnosing glaucoma in primary eye care and the role of Artificial Intelligence applications for reducing the prevalence of undetected glaucoma in Australia

Catherine Jan, Mingguang He, Algis Vingrys, Zhuoting Zhu & Randall S. Stafford

Eye **38**, 2003–2013 (2024) | Cite this article

Applications



ONH OCT

- The RNFL thickness is one common parameter utilised for glaucoma diagnosis and became a key focus in ML using OCT images.
- Since 2005, studies have reported the performance of ML algorithms analysing OCT imaging data from peripapillary RNFL thickness maps and the macular ganglion cell complex for detecting GON, with AROC values ranging from 0.69 to 0.99.
- Deep Learning (DL) network achieved an AROC of 0.94 for detecting GON using unsegmented OCT volumes of the optic nerve head.

VISUAL FIELD

- DL algorithms to diagnose glaucoma with data from standard automated perimetry (SAP) with Humphrey VF 24-2 and 30-2 SITA standard VF test outperformed the diagnostic accuracy of glaucoma experts in differentiating normal from glaucomatous VFs, with a sensitivity of 93% and specificity of 83%.

- Furthermore, algorithms trained using a combination of OCT images and SAP VF results reached an AROC of 0.98 for identifying patients with glaucoma.

AS-OCT

- AS-OCT images can also be processed for structure segmentation, measurement, and screening for angle closure using algorithms being developed

- Niwas et al evaluated a fully automated model to classify angle closure glaucoma from AS-OCT scans and showed an accuracy of 89.2%.

> Comput Methods Programs Biomed. 2016 Jul;130:65-75. doi: 10.1016/j.cmpb.2016.03.018. Epub 2016 Mar 21.

Automated anterior segment OCT image analysis for Angle Closure Glaucoma mechanisms classification

Swamidoss Issac Niwas [1], Weisi Lin [2], Xiaolong Bai [3], Chee Keong Kwoh [4], C-C Jay Kuo [5], Chelvin C Sng [6], Maria Cecilia Aquino [7], Paul T K Chew [8]

Affiliations + expand

PMID: 27208522 DOI: 10.1016/j.cmpb.2016.03.018

Multi-modal AI models

- Research has also utilised multimodal structural data to enhance the assessment of glaucomatous structural damage from optic disc photographs for segmentation and detection .

- A recent multimodal model was developed using the **Xception model** for image feature extraction and various ML showed impressive area under the receiver operating characteristic curve (AUROC) values for the different algorithms: RF had an AUROC of 99.56% while analysing the vertical cup-to-disc ratio and mean RNFL thickness in the detection of glaucoma in a population with high incidence of myopia.

DETECT PROGRESSION

- AI can predict future visual field progression and help guide treatment decisions.
- Wen et al have developed deep learning systems that can predict future visual fields for up to 5.5 years based on a single input visual field.

LIMITATIONS

- High myopia caused false negatives.
- Physiological cupping caused false positives.

IN A NUTSHELL

- AI is a breakthrough all science fields nowadays.
- It helps in screening of glaucoma.
- It all depends on your input.

THANK YOU