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RSSDI Diabetes Update 2019

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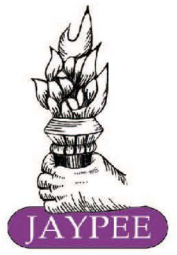
Siddharth N Shah



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4 CHAPTER Screening for Diabetic Retinopathy—Need of an Hour

Bhargav Sosale, Bhavana Sosale

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INTRODUCTION

India has close to 73 million individuals with diabetes.[1] Microvascular and macrovascular complications of diabetes lead to morbidity and mortality and increase cost of care. The goals of treatment of diabetes include prevention of complications or reduction in the progression of complications in those with preexisting complications.

Many individuals with diabetes remain undiagnosed as the disease is asymptomatic in the initial stages. Hence, complications may be present even at the time of diagnosis of diabetes. Screening for complications from 'day 1' is of paramount importance.[2]

Diabetic retinopathy (DR) is a microvascular complication of diabetes. It is a leading cause of blindness across the world in individuals with type 1 diabetes mellitus (T1DM) and type 2 diabetes mellitus (T2DM). The risk factors for development of DR include duration of diabetes, degree of glycemic control, smoking, hypertension, and dyslipidemia.

Prolonged hyperglycemia leads to various pathophysiological pathways such as sorbitol pathway, accumulation of end glycosylation products, protein C activation and microvascular occlusion, impairment in vascular signaling pathways, production of reactive-oxygen species, renin-angiotensin aldosterone system upregulation and finally results in a common pathway that causes hypoxia and end-organ ischemia.[3]

RATIONALE FOR EARLY SCREENING

Studies such as Chronic Complications in Newly Diagnosed patients with type 2 diabetes in India (CINDI), CINDI 2, and the Chennai Urban Rural Epidemiology Study (CURES) have estimated the proportion of individuals with micro- and macrovascular complications at diagnosis in India. CINDI included 4,600 individuals newly diagnosed with T2DM, and CINDI 2 included 1,500 individuals with new-onset T2DM under the age of 40 years, also known as young-onset diabetes (YOD). CINDI 1, CINDI 2, and CURES reported the proportion of individuals with DR at the time of diagnosis of diabetes as 6%, 5% and 5%, respectively.[4–6]

SCREENING METHODS

Man, or Machine?

A dilated comprehensive retinal examination should be performed by an ophthalmologist to screen for DR.[2] Only about half the individuals when referred visit the retina specialist for an evaluation. Travel time, distance, and pupil dilatation are challenges to screening.

High-quality retinal imaging can be considered as an alternative to remotely screen patients in areas without access to a retinal specialist. Ideally, retinal photographs must be taken and stored at each examination. Challenges with telemedicine include Internet access, availability of a fundus camera, and accessibility of a retina specialist to read the image.

Artificial intelligence (AI) algorithms for screening for DR have also been developed over the past few years. IDx, Eyenuk, and Remidio Innovations Solutions Pvt. Ltd. are some of the tech companies working in this arena. These algorithms use big data and advances in machine learning and neural networks to recognize normal and abnormal patterns in the retinal images and produce an output of a healthy or an unhealthy image. Artificial intelligence algorithms have been trained and validated for the detection of referable DR (more than mild nonproliferative DR).



Figure 1 The Remidio NM fundus-on-phone camera.

Most AI algorithms work on cloud-based platforms where the image uploaded online is analyzed by the software and a report is generated. Studies report the sensitivity of IDx-DR and Eyenuk in the diagnosis of DR as 87% and 95.8%, respectively.[7,8] These systems work with a traditional large, expensive table-top fundus camera. The cost of equipment and the need for high-speed Internet are challenges. The only exception is the portable Medios AI with the Remidio Fundus on Phone (FOP) which works completely offline.

The AI algorithm developed by Medios Technologies, a subsidiary of Remidio, is a novel system and a first of its kind in the field of DR.

The AI is integrated into a portable smartphone-based fundus camera, called the Remidio non-mydriatic (NM) FOP, and works offline (Fig. 1). This cost-effective, small camera produces images comparable with Topcon and Zeiss and has been validated in clinical studies.[9] The AI produces a binary report of DR versus no DR in a few seconds after the retinal image is captured (Figs. 2A and B and 3A to D). The AI in a landmark study by Natarajan et al. demonstrated a sensitivity and specificity of 100% and 88.4%, respectively, in the diagnosis of referable DR (more than moderate nonproliferative DR).[10] The AI has been validated with both mydriatic and nonmydriatic images (SMART STUDY).

WHEN SHOULD WE SCREEN PATIENTS FOR DIABETIC RETINOPATHY?

Individuals with T1DM should undergo screening within 5 years after the onset of diabetes or at age > 10 years or the onset of puberty (whichever is earlier).[2] Individuals with T2DM should undergo screening at the time of diagnosis of diabetes. Women with preexisting diabetes who are planning pregnancy should be screened prior to conception or in the first trimester. Subsequent monitoring every trimester may be indicated if retinopathy if present.

HOW OFTEN SHOULD THE RETINAL EXAMINATION BE REPEATED?

Individuals with no evidence of DR can be screened annually.[2] The presence of retinopathy necessitates more frequent monitoring (every 3–6 months based on the severity of disease). Monitoring intervals post laser or after vitrectomy or treatment of maculopathy can vary from monthly to every 4–6 months after stabilization.

ARTIFICIAL INTELLIGENCE AND DIABETIC RETINOPATHY SCREENING

There is a large scope for the use of AI algorithms for DR diagnosis. These technologies can create a significant public health impact as they can make DR screening scalable.

The biggest challenge to screening today is the lack of ophthalmologists in urban, rural, and semiurban areas. Making such technology accessible can aid general practitioners, family physicians, and health-care workers at the most basic levels of care in screening for DR. Early diagnosis at the grassroot level can prevent blindness by ensuring early referral and treatment.

The Medios AI with the Remidio FOP has been validated with nonmydriatic and mydriatic images. The ability to screen without mydriasis reduces screening time. Elderly individuals or those with small pupils (<3 mm) can still be screened after dilatation with a drop of tropicamide. The use of the equipment requires no technical skill, and anyone can be trained to use such devices and capture retinal images for diagnosis. This was also seen in the study reported in JAMA Ophthalmology, where minimally trained health-care workers used this device to screen for DR in community-based health- care dispensaries.[10]

WHO SHOULD SCREEN?

Clinical practice recommendations recommend screening by an ophthalmologist. The number of individuals with diabetes greatly surpasses the number of ophthalmologists.[11] Studies have also shown that intergrader difference and clinical training play a big role in diagnosis and grading of DR. Studies comparing retinal

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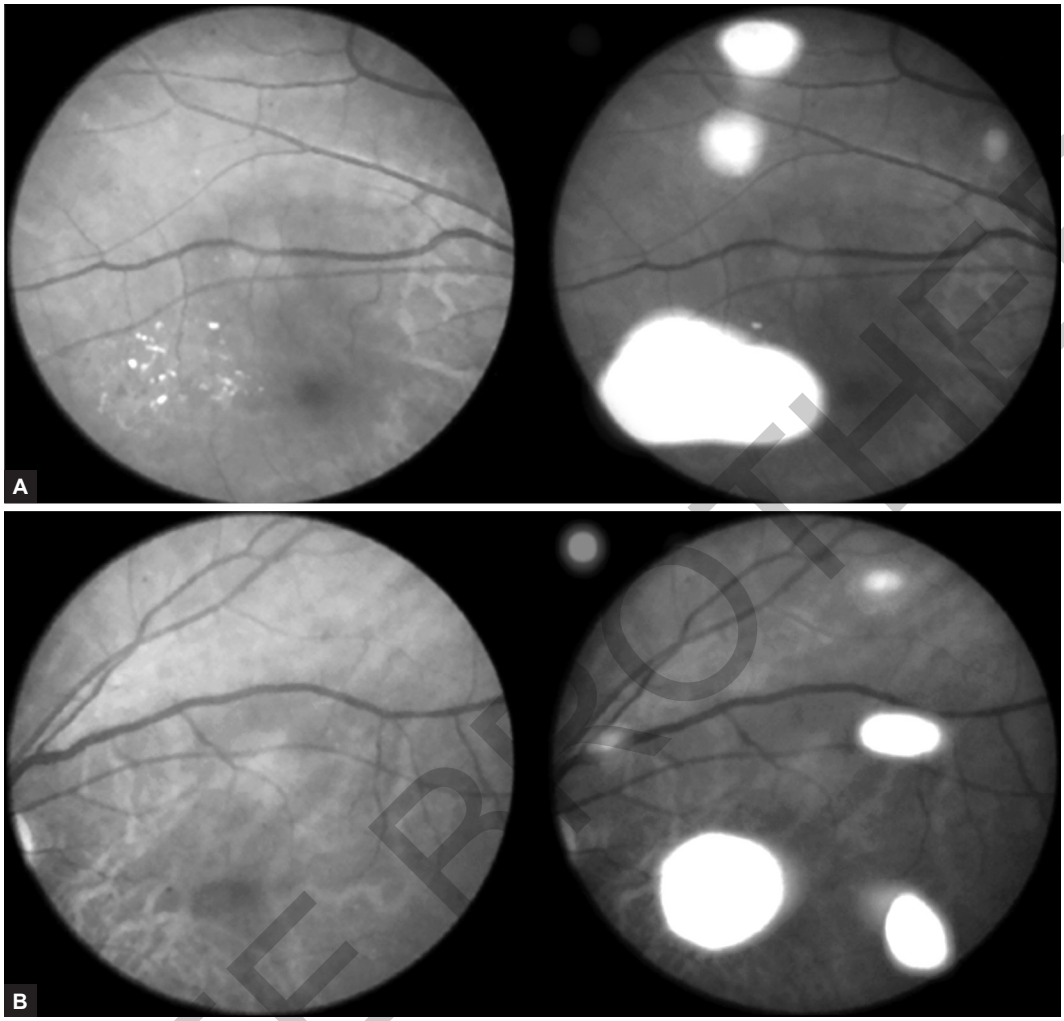

Result: Signs of retinopathy detected. Examples of lesions are highlighted.
Confidence: 99%

Figures 2A and B An example of the PDF report generated by the Medios AI in an individual with diabetic retinopathy.
(For color version see color plate No. 1)

(*Source*: Medios AI.)

specialists, general ophthalmologists, and optometrists have observed a greater precision when patients are screened by a retina specialist > general ophthalmologist > ophthalmic nurses.[12] If only retinal specialists were to screen for DR, the entire burden of screening a country would rest on the retina specialists.

We need to move from a 'treatment focused' health-care system toward a 'prevention focused' health-care system and large-scale screening programs are the need of the hour.

It is thus imperative for all health-care workers, nurses, doctors, family physicians, general practitioners, diabetologists, endocrinologists, ophthalmologists, and retina specialists to take care on the challenge of screening. Artificial intelligence can help achieve this and make screening accessible and affordable to those who need it most.

Screening for DR using AI algorithms is a paradigm shift in diabetes care. Artificial intelligence can help every physician and health-care worker prevent blindness by ensuring early screening for detection of DR.

CONCLUSION

Screening for DR is the need of the hour. Technology and AI can aid all doctors and health-care workers in

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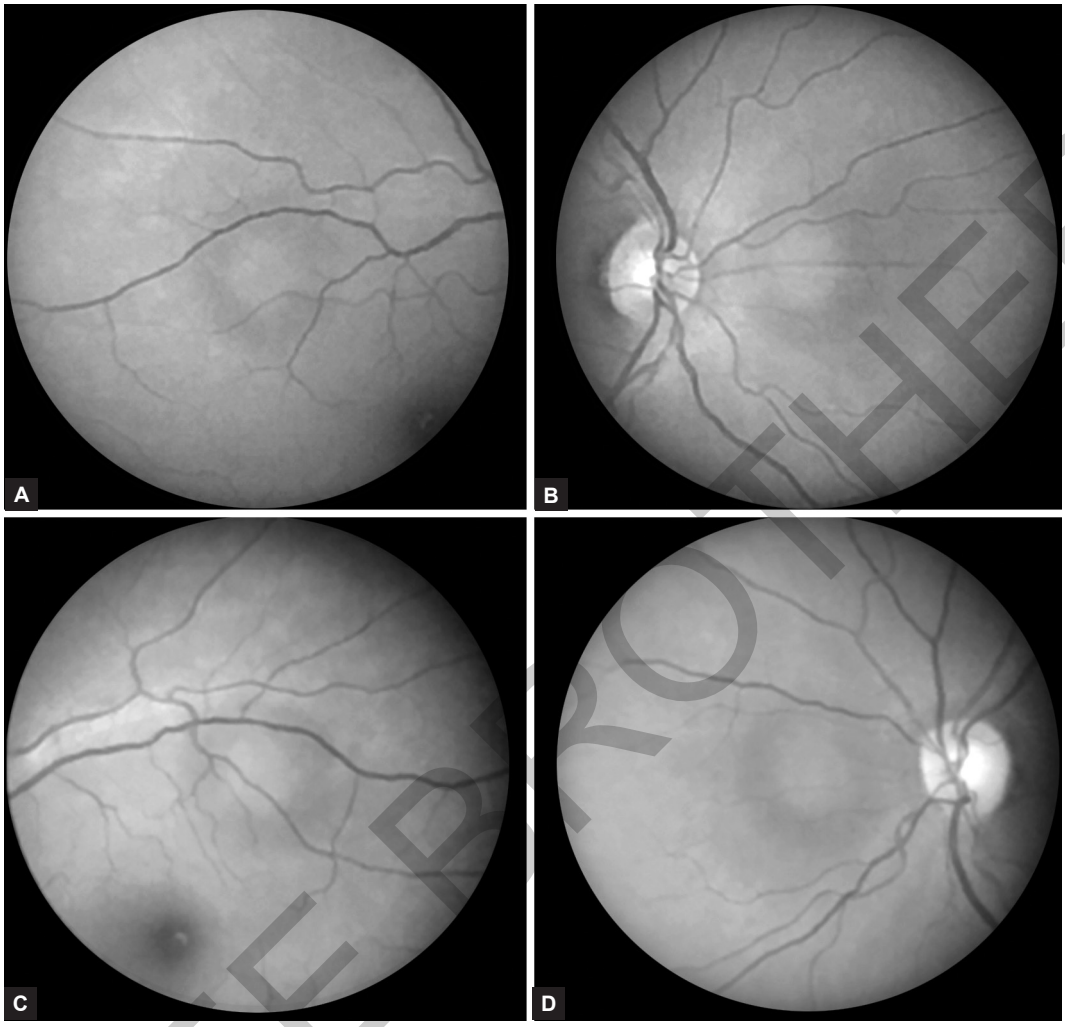

Result: No signs of retinopathy detected. Re-examine after 6 months.
Confidence: 87%

Figures 3A to D An example of the PDF report generated by the Medios AI in an individual without diabetic retinopathy.

(*Source*: Medios AI.) ***(For color version see color plate No. 2)***

solving public health problems on a large scale. Use of novel technologies like the Medios AI with the low-cost portable Remidio NM FOP can help scale DR screening and prevent blindness even in resource-limited settings with no Internet or electricity.

It is time for man to work with the machine. Recent advances indicate a turning point in diabetes care, the time when the physician can focus on prevention of blindness.

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RSSDI Diabetes Update 2019

Key Features

- The current edition of *RSSDI Diabetes Update 2019* comprises a wide range of topics extending from the basic anatomy and physiology of the islet, alterations in cell biology and functioning, and etiology and the text has been segregated into sections with related subtopics in each section to make it well organized and reader-friendly
- Epidemiology, pathogenesis, molecular mechanisms, entire spectrum of clinical aspects, controversies as well as research methodologies have been very well covered
- Divided into 15 sections having 92 chapters, the book will enhance knowledge and has the potential to provide ideas for innovation and new research in the field
- The title includes articles and updated guidelines with vast knowledge and skill base in the field of Diabetology
- Simple language and presentation enable this update to serve as a handy reference guide to not only diabetes physicians and endocrinologists, but also primary care practitioners, postgraduate students and internists.

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