My journey in ophthalmology as a retina-vitreous surgeon: Crusade against blindness due to diabetic retinopathy

Aravind Eye Hospital, a part of Aravind Eye Care System (AECS), was established in 1976 by a non-profit trust—Govel Trust—founded by Dr. G. Venkataswamy. I feel privileged to be one of the founding members of AECS. I joined as an ophthalmologist, took up several leadership positions, and I am currently the Chairman Emeritus of AECS. The mission of Aravind is to “eliminate needless blindness by providing compassionate and quality eye care affordable to all.” Today, the AECS encompasses seven tertiary eye care centers; seven secondary eye care centers; six community eye clinics; 105 primary eye care centers (called Vision Centers); the Postgraduate Institute of Ophthalmology; a manufacturing center for ophthalmic products (Aurolab); the Aravind Medical Research Foundation (AMRF); an eye care consultancy and management training center called Lions Aravind Institute of Community Ophthalmology (LAICO). Aravind is recognised by the World Health Organization (WHO) as a collaborating center for the prevention of blindness.

My Entry into Ophthalmology and the Journey to Become a Vitreo-Retinal Surgeon

It was not planned. It just happened, organically. A chain of events was set in motion that ultimately resulted in me becoming a vitreo-retinal surgeon.

I was born into an agrarian family in a small village called Ambasamudram in the Theni district of Tamil Nadu. My father had a basic education, but my mother never went to school. Our village was in a remote corner and the people there did not have much exposure to the vast world of opportunities. Education was not a priority to many. Thanks to my parents’ determination and perseverance, I and my siblings received education. It was not an easy task; constantly, they had to borrow money and I had to get scholarships from the government in order to go to medical school. I took up medicine after schooling, according to my father’s wish, and graduated in 1963. I did my undergraduate and postgraduate education in Madurai Medical College.

In 1965, I got married to Dr. Natchiar, who was the younger sister of my then ophthalmology professor Dr. G. Venkataswamy [Fig. 1]. It was a turning point in my personal and professional life. In Dr. Venkataswamy, I saw my mentor, and it was he who urged me to take up ophthalmology. His entry into my life was perfectly timed. For a youth who often stood confused, he showed me a path, and not only that, he guided me along as well. But for his influence and mentoring, I would not have reached where I am now. He played a pivotal role in shaping and grooming me in every aspect of my career. My association with him for more than 40 years as a student, a family member, and as a colleague has had a tremendous influence on me. After graduating in 1966 as an ophthalmologist, I joined as a medical officer in the Low Vision Clinic at the Government Hospital, Madurai. I handled a US-aided project which was later absorbed by the Government of Tamil Nadu along with the staff. During my service in Government Rajaji Hospital from 1966 to 1976, I had the privilege of attending every eye camp in the nook and corner of Tamil Nadu with Dr. Venkataswamy. I had the opportunity to travel with him and assist him in surgery and gain experience in community ophthalmology and management.

Gradually, I developed great interest in the posterior segment diseases of the eye and their management and used to practice indirect ophthalmoscopy on my own. The eye department of the Government Erskine Hospital, led by Dr. G. Venkataswamy, attracted many visitors from abroad. Dr. Morton F. Goldberg, Director of the Department of Ophthalmology, University of Illinois, was one among them and he offered a two-year fellowship in Diabetic Retinopathy Study (DRS) in 1972 [Fig. 2]. I had the privilege of being a part of the well-known multi-center clinical study on diabetic retinopathy (DR) conducted by the National Eye Institute, USA. I underwent medical retina fellowship training with Dr. Gholam Peyman and Dr. Morton Goldberg.

Another milestone in my career was the training in surgical retina in Boston. In 1976, while I was in the government service, Dr. Charles L. Schepens, the father of retinal surgery and the inventor of binocular indirect ophthalmoscopy, visited in connection with developing an instrument similar to the current phaco machine. When he learned that I was interested in surgical retina specialty, he offered a fellowship for 18 months even without a formal interview. This was a major turning point in my career and presented a unique opportunity for training under the expert guidance of none other than Dr. Schepens at the Retina Associates, Harvard Medical University, Boston [Fig. 3]. Though the offer was extremely exciting, it also posed a set of challenges. I was in the government service and had to apply for leave for 18 months to go for training. My leave request was turned down since I had not completed the bond period sanctioned for my previous training abroad. A challenging decision to make, yet, I chose to resign from the government service. Leaving a
A government job was a blessing in disguise as it paved the way for me to join Dr. G. Venkataswamy and start Aravind Eye Hospital. After training in USA under Dr. Gholam Peyman, the Vitreous Surgery Centre was founded at the Government Rajaji Hospital, Madurai, in 1975, the first of its kind in India, and then the Retina Vitreous Clinic at Aravind Eye Hospital in 1979. We started the Vitreo-Retina Fellowship at Aravind Eye Hospital, Madurai, in the early 1980s. It is truly gratifying to see that many of my fellows are now heading vitreo-retinal departments all over the country.

**Diabetic Retinopathy**

Though cataract continues to be the leading cause of blindness, the intense work under the National Programme for Control of Blindness (NPCB) with the support of international non-governmental organizations (NGOs) has brought down its contribution to blindness in India from 80% in the year 1988 to 62% in 2002. The rate of blindness due to cataract has come down from 1.7% to 0.8%. Cataract surgery performance increased from 1.2 million to 5.3 million. Diabetic Retinopathy (DR) is one of the priority eye diseases targeted by VISION 2020: The Right to Sight – India (V2020 India) in its fight against avoidable blindness.

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**Magnitude of Diabetes and DR**

As per the data available for 2019, India occupies second place in the world with 77 million diabetes patients. This is expected to increase to 101 million and 134.2 million by 2030 and 2045, respectively, between the ages 20 and 79 years. The prevalence of diabetes is 12.1 million for those above the age of 65 years and is expected to increase to 18 million in 2030 and 23.2 million in 2045. Thus, it is high time that we concentrate on DR and bring the problem under control as we have significantly brought down the problem of blindness due to cataract.

Various studies conducted in India found that 12%–18% of the diabetic population will have diabetic retinopathy and only 5%–10% of cases will have sight threatening retinopathy requiring active intervention by trained retinal surgeons. The rest will have normal fundus with good vision and no retinopathy and hence, need only a periodic follow-up by a diabetologist and ophthalmologist. Intense control of hyperglycemia, high blood pressure, and lipids has a positive and beneficial effect on the prevention or postponement of the progression of DR, and the recent published reports are supportive of the fact that the need for laser treatment for diabetic macular edema for type II diabetes mellitus (DM) has come down to 43% (2001–2006), though the prevalence of DM has dramatically increased. But all the recent advances in investigation, diagnosis, gadgets for latest treatment, and pharmacological development are directed toward the patients who have already developed DR. Our aim should be to reduce the number of diabetes patients who will need lasers and vitrectomy. Since the disease is asymptomatic in the stages which are amenable for treatment, every diabetes patient needs detailed dilated fundus examination, and thus all 77 million
diabetes people will need DR screening. Early detection and management are crucial to prevent vision impairment.

In India, the number of trained medical professionals to treat DR is low. Only 12%–15% of the 16,000 ophthalmologists are trained in the management of DR. People also do not seek treatment due to lack of awareness of the condition or non-availability of resources and specialists.[9] All diabetes patients have to be detected and screened early on for DR. This is the only effective way to prevent blindness. The main challenges in DR management are inadequate facilities for diagnosis and treatment and lack of awareness amongst the diabetes patients on the need to undergo periodic eye examination. Awareness should be created among healthcare professionals as well to urge their diabetes patients to undergo routine eye check-ups.

**Aravind Initiatives to Tackle DR**

Aravind focused to address the above-mentioned challenges and initiated the fight against vision impairment due to DR.

My training and the experience gained out of the Diabetic Retinopathy Study Program in USA was instrumental in developing a number of innovative models for awareness creation, screening, service delivery, research, and development activities related to the disease. This thought culminated in the launch of the first project in 2000 which was a joint effort by Aravind and the Lions Club International Foundation (LCIF). The project with LCIF was for a period of five years starting in 2000 and focused on awareness creation, service delivery, training, and model development. As part of this, special camps were organized in association with diabetologists to identify diabetics among the population, detect DR among the diabetics, and render treatment including laser. These camps also served to create awareness on DR in the community.

Aravind also initiated a project in association with the World Diabetes Foundation (WDF), Denmark, to combat blindness due to DR. It covered a large population of about 24 million in Tamil Nadu. The project also harnessed the advantages of information technology through the establishment of remote screening based at Aravind Eye Hospital, Theni. With the help of the Indian Space Research Organisation (ISRO), a mobile van with VSAT connectivity was commissioned at Madurai to screen patients through digital imaging, the results of which were then transmitted to a reading and grading center for expert opinion and appropriate treatment [Fig. 4].

**TIFAC-CORE Centre of Relevance and Excellence**

In 2003, Aravind in collaboration with the Technology Information, Forecasting and Assessment Council (TIFAC), brainchild of the former Indian President, Dr. APJ Abdul Kalam under the Department of Science and Technology, Government of India, created a Centre of Relevance and Excellence (CORE) in DR at Aravind Eye Hospital [Fig. 5]. It aimed to make Aravind a premier research and training center for DR in the world through state-of-the-art technology and practices. It envisaged molding Aravind to become one of the best referral centers for DR.

As part of the TIFAC-CORE, the retina and vitreous department of Aravind Eye Hospital introduced various academic programs such as certificate courses in DR, fluorescein angiography, and ultrasonography, as well as a fellowship in DR [Fig. 6]. AMRF provided the expertise needed for conducting basic research in molecular genetics and the pathogenic mechanism of DR. Aurolab developed an indigenous, low-cost green laser for DR management. This highly affordable green laser (532 nm) with a slit-lamp adapter is now widely used for the photocoagulation of tiny blood vessels that proliferate with the onset of diabetic retinopathy [Fig. 7].

Continuing medical education programs, too, were arranged periodically in collaboration with international institutions like the Joslin Diabetes Center, Boston, USA, and the University of Wisconsin–Madison, USA.

**Consultations for the Effective Management of DR**

Aravind played a major role in organizing various consultative workshops to address the challenges in the management of DR and actively took part in these deliberations.[9] These included a workshop organized by the WHO at Geneva for its member states. The deliberations that came out of this meeting were published by the WHO in the form of a report titled “Prevention of blindness from Diabetes Mellitus for the benefit of the member states of WHO.”

Aravind, in association with the Indian Council of Medical Research (ICMR), New Delhi, also organized a taskforce meeting on “Prevalence of Diabetic Retinopathy”.

**Development of a Service Delivery Model**

The experience gained through implementing various projects resulted in Aravind developing a service delivery model to tackle DR [Fig. 8]. This model comprised screening, awareness creation, training, and capacity building. Aravind developed a manual named “Guidelines for the comprehensive management of Diabetic Retinopathy in India” which was published by V2020 India and is now used by several programs as a framework for developing their own DR services in a comprehensive manner.[9]

**Awareness Creation and Screening Strategies**

Awareness creation is one of the strategies in the management of DR. A knowledge, attitude, and practice (KAP) study found
that only 60% of paramedical personnel were aware about diabetes and 22% of doctors did not know about DR. Hence, conducting a KAP study is highly recommended as it will help one to understand the level of awareness, beliefs, and practices about diabetes and DR and accordingly develop information, education, and communication (IEC) materials. Development of IEC materials like pamphlets and posters in local languages will be of great use.\[7\]

**DR Screening Camps**

Screening of the general population for diabetes and detection of DR in the diabetic population is the first step in the management of the disease. In a DR screening camp, a team of medical and paramedical personnel with sufficient diagnostic equipment work linearly with diabetes clinics to screen diabetes patients for DR. Those identified with DR are referred to a tertiary eye care center for treatment.

**Mobile Screening**

It is a known fact that there are not enough ophthalmologists to examine all diabetes patients and screen for DR. To address this, an advanced mobile eye screening unit equipped with a qualified technician and telemedicine facility was commissioned.\[8\] The van has all the necessary diagnostic equipment and travels to rural areas or to physicians’ clinics, screens patients and captures high-quality images of the retina. These images are then shared with a retina specialist in the base hospital using a special software developed by Aravind called the Aravind Diabetic Retinopathy Evaluation Software (ADRES)\[9\] (Fig. 9). The specialist makes the diagnosis, if necessary, interacts with the patient through video conference, and sends the report back which is printed out and given to the patient with appropriate counseling. This advanced eye screening benefits the patients, especially the diabetics to receive expert opinion immediately.

**Screening for DR at Diabetologist’s Clinics**

Instead of searching for diabetes patients in the population, an opportunity is available to examine all known diabetes patients who attend a diabetologist’s clinic. The first point of contact for a diabetes patient is a diabetologist or a physician.\[10\] Trained technicians posted at the diabetes clinics can take the fundus images and send them to the nearest eye hospital for an ophthalmologist’s opinion. The report can be printed and given to the patient immediately. Fundus examination helps in monitoring the severity of diabetes, major blood vessel involvement, and evaluation and management of DR, in addition to blood pressure, HbA1c, lipid profile, etc.

**Networking with Primary Health Centers**

Realizing that public-private partnership model of delivering care would reach out to many more, Aravind started this concept in Tamil Nadu. This involved networking with primary health centers (PHCs) to screen known diabetes patients. Diabetes patients in the community visit the PHC on a fixed day to collect their free medications for the week.Utilizing this opportunity, a mobile van equipped with all the necessary diagnostic equipment was organized to visit the PHCs and screen patients. The health personnel at the PHC were also oriented toward the need for screening the diabetes patients so that they also extended their full support.

**Detecting DR Using Artificial Intelligence**

Artificial intelligence (AI) is gaining great significance in different aspects of our life. Its potential in healthcare is very vast. This can be applied in DR management too. Using deep learning techniques, Google in collaboration with Aravind, has developed a self-optimizing algorithm that can examine large numbers of fundus photographs and automatically detect DR and diabetic macular edema with a high degree of accuracy.\[11\] The eventual goal is to increase access to care and reduce the cost of screening and treatment for diabetic eye disease, especially in under-resource environments.

**Consultancy and Capacity Building**

LAICO, a unit of AECS has been involved in developing capacities of eye hospitals to deal with the problem of blindness. LAICO, with support from Sightsavers, offered consultancy...
and capacity building programs for the effective management of DR to Sightsavers-supported eye hospitals. Many short-term training programs on indirect ophthalmoscopy and lasers in DR were organized. LAICO also helped to set up DR services in Peking University Eye Center, Eli Lilly Diabetic Eye Disease Center (PUEC-ELDED) Beijing, China, supported by the International Council of Ophthalmology (ICO) Foundation, USA.

**Research in DR**

One of the effective ways to improve the management of DR is to identify the risk groups amongst DM and DR individuals.

A population-based, cross-sectional study conducted for the first time in the Theni district of Tamil Nadu, India, by Aravind showed that 22% of patients had DR, of which 8.9% had a severe form of the disease. While this marker was found to be altered significantly in the DR patients in the Indian study cohort only. This finding suggests that DR patients in India have a more pronounced inflammatory status than those in the UK. Apart from the validation of three serum proteins as DR biomarkers, through another independent validation study, the AMRF identified fibronectin and thrombospondin to be altered significantly in the sera of DR patients. These results highlight the importance of examining the Indian population in particular for the detection of population-specific biomarkers.

The research team at the AMRF also compared the serum microparticle proteome across six patient categories representing different stages of disease: Non-DM, Type 2 DM (T2DM), three non-proliferative diabetic retinopathy (NPDR) stages (mild, moderate, severe), and PDR. This comparative analysis identified many microparticle proteins that were altered significantly during DR progression. Importantly, these proteins were not identifiable in the bulk serum proteome. They validated eight of these microparticle proteins in a large validation cohort and identified two proteins, CD41/61 and peroxiredoxin 2, as DR biomarkers.

Apart from proteins, miR451a and miR181a were upregulated in T2DM conditions and downregulated in NPDR and PDR conditions, and miR320a and miR27b showed a progressive increase in expression from DM to DR conditions. The above results were also validated. In addition to serum, vitreous humor from PDR patients was also found to be a useful source of biomarkers. Many proteins were altered significantly in the FDR vitreous including the complement pathway proteins. Further studies are in progress.

In summary, the biomarker studies resulted in the identification of a panel with five serum proteins, two serum microparticle proteins, one vitreous humor protein, and four microRNAs (miRNAs). The AMRF has validated all these lab findings. Now it is in the process of developing a sensitive clinical assay to use in the clinic or in the field. Additionally, it has accumulated more than 1000 well-characterized human samples in its biobank, which will be of great use for future research. The AMRF recently started a nanomedicine initiative based on exosomes to understand disease pathology and possible therapy.
Figure 8: DR service delivery model of Aravind

Figure 9: Mobile van screening for DR using ADRES software

Figure 10: Genetic and proteomic research to identify DR biomarkers
Conclusion

My entry into ophthalmology and journey to becoming a retina-vitreous surgeon would not have been possible if not for the guidance and constant encouragement of Dr. G. Venkataswamy, Dr. Morton Goldberg Dr. Gholam Peyman, and Dr. Charles L. Schepens. I have to acknowledge that the key for success and progress in our career lies in achieving the balance between our aggressive behavior with young and energetic spirit along with giving value for the wisdom and experience of our seniors in the profession.

India is home to the largest diabetic population in the world, and so the number of people who are at risk of developing DR is significantly high. Much has been done in the field of DR management. As I look back at my career spanning over fifty years, I get a strong sense of satisfaction that my efforts have helped develop a number of innovative models for awareness creation, screening, service delivery, and research and developmental activities related to DR. Yet considering the high prevalence of the disease in India and the growing number of diabetic population, newer modalities need to be experimented especially in case finding and intervention. Concentrated and coordinated efforts of ophthalmologists, diabetes specialists, and other healthcare providers are required for this. Our aim should be to reduce the number of diabetes patients who will need laser or vitrectomy for DR management. India is becoming the diabetes capital of the world, and we, the ophthalmic fraternity, should take the lead to tackle the problem and reduce needless blindness due to diabetic retinopathy.

Let us face it with faith, confidence, determination and a “We can do it” attitude. May Swami Vivekananda’s words be our guiding light in this journey:

“Take up one idea. Make that one idea your life; dream of it; think of it; live on that idea. Let the brain, the body, muscles, nerves, every part of your body be full of that idea and just leave every other idea alone. This is the way to success.” – Swami Vivekananda

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References

1. Gilbert C, Raman U, Francis V. World Blindness and Its Prevention. Vol. 7. International Agency for the Prevention of Blindness. General Assembly. Oxford University Press, 2005.
2. Aravind Eye Care System. Guidelines for the Comprehensive Management of Diabetic Retinopathy in India: A VISION 2020: The Right to Sight INDIA Publication. Aravind Eye Care System; 2008. Available from: https://www.iapb.org/wp-content/uploads/Guidelines-for-the-Comprehensive-Management-of-DR-in-India.pdf.
3. Saeedi P, Petersohn I, Salpea P, Malanda B, Karuranga S, Unwin N, et al. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas, 9th edition. Diabetes Res Clin Pract 2019;157:107843.
4. World Health Organization. Prevention of blindness from diabetes mellitus: Report of a WHO consultation in Geneva, Switzerland, 9-11 November 2005. Geneva: World Health Organization; 2006. Available from: https://apps.who.intiris/handle/10665/43576.
5. Namperumalsamy P. Hope insight. J Ophthalmol Clin Res 2021;1:3-6.
6. World Health Organization. Regional Office for South-East Asia. Strengthening diagnosis and treatment of Diabetic Retinopathy in SEA Region. World Health Organization. Regional Office for South-East Asia; 2020. Available from: https://apps.who.intiris/handle/10665/334224.
7. Namperumalsamy P, Kim R, Kalaiaperumal K, Sekar A, Karthika A, Nirmalan PK. A pilot study on awareness of diabetic retinopathy among non-medical persons in South India. The challenge for eye care programmes in the region. Indian J Ophthalmol 2004;52:247-51.
8. Ramasamy K, Mishra C, Kannan NB, Namperumalsamy P, Sen S. Telemedicine in diabetic retinopathy screening in India. Indian J Ophthalmol 2021;69:2977-86.
9. Perumalsamy N, Prasad NM, Sathyra S, Ramasamy K. Software for reading and grading diabetic retinopathy: Aravind Diabetic Retinopathy Screening 3.0. Diabetes Care 2007;30:2302-6.
10. Namperumalsamy P. Guidelines for diabetic retinopathy screening in a large population rationale for diabetic retinopathy services in India. Retina Today. 2008. Available from: https://retinatoday.com/articles/2008-sept/0908_09-09-php.
11. Gulshan V, Peng L, Coram M, Stumpe MC, Wu D, Narayanawamy A, et al. Development and validation of a deep learning algorithm for detection of diabetic retinopathy in retinal fundus photographs. JAMA 2016;316:2402-10.
12. Namperumalsamy P, Kim R, Vignesh TP, Nithya N, Royes J, Gijo T, et al. Prevalence and risk factors for diabetic retinopathy: A population-based assessment from Theni District, south India. Br J Ophthalmol 2009;93:429–34.
13. Gurudas S, Frudd K, Maheshwari JJ, Revathy YR, Shivaprasad S, Ramanath SM, et al. Multicenter evaluation of diagnostic circulating biomarkers to detect sight-threatening diabetic retinopathy. JAMA Ophthalmol 2022;140:587-97.