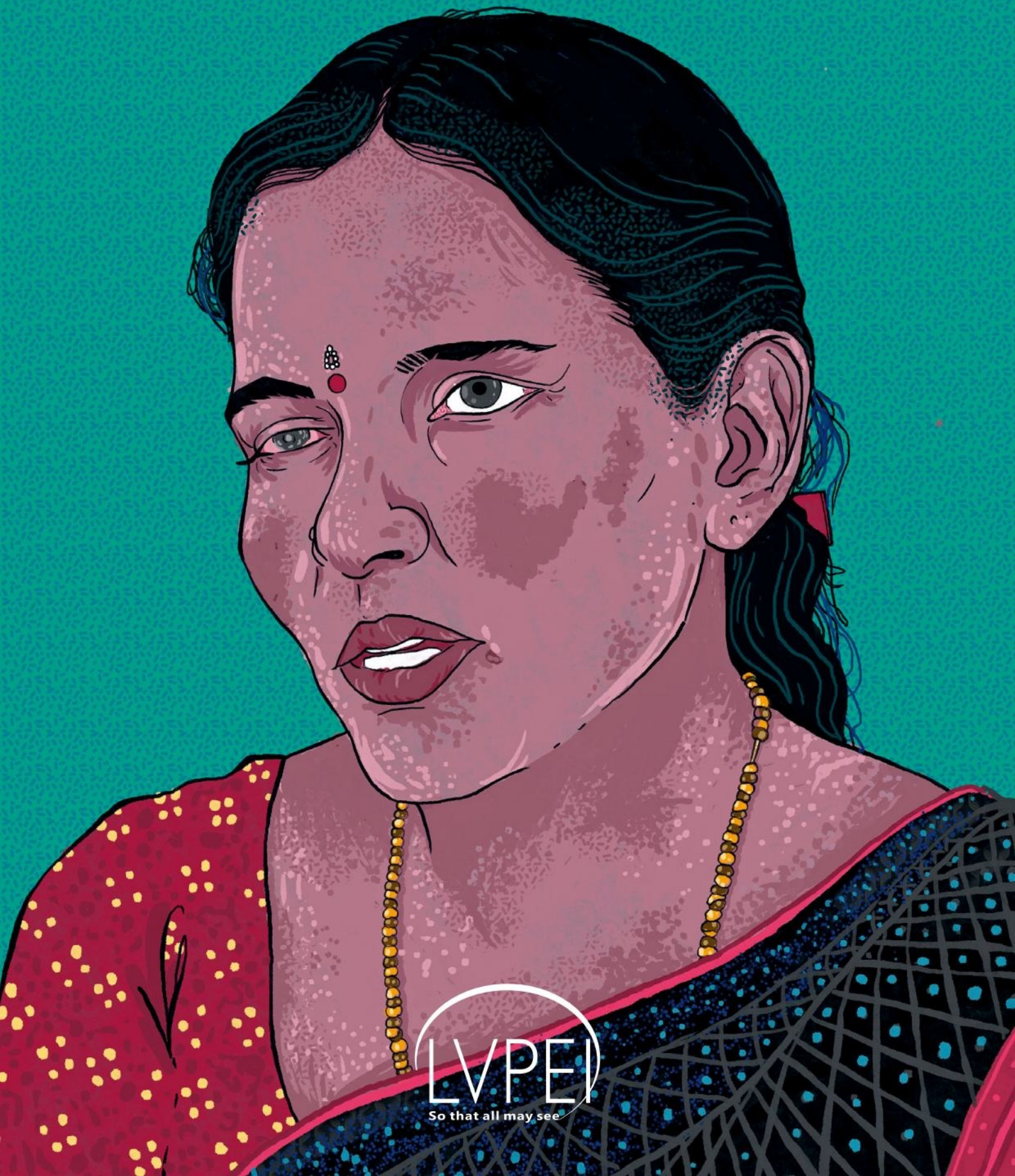
THE SHANTILAL SHANGHVI CORNEA INSTITUTE

Opportunities

2022–23



LVPEI

So that all may see

Vision

A world where anyone with a corneal impairment can access and afford treatment, irrespective of their location or ability to pay.

Mission

To reduce the impact of treatable corneal blindness by 50%, by 2035.

Areas of work

Patient care
Eye banking
Clinical education
Capacity building
Research
Product innovation
Public health

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Cover image

An illustration of Sushmita, a corneal infection survivor.

Illustration by Satwik Gade.

Opportunities

Corneal blindness has a complex etiology and can be challenging to manage depending on stage of presentation and the socioeconomic realities of the patients. The causes are many: agricultural work opens up the risk of abrasions to the eye, leading to corneal infections, occupational hazards expose workers to chemical and thermal injuries while children are particularly prone to eye injuries. Corneal blindness is not delineated by poverty alone; contact lens-care may also result in infection. Dry eye disease is a looming public health burden for most countries in the world. Trachoma is a blinding infection found in several tropical countries in Africa, Central and South America, and perhaps, in pockets of India, Pakistan and Nepal as well. Trauma, vitamin A deficiency – all result in a global corneal disease burden that is, unfortunately, not fully documented.

Trainee learning to perform a Descemet's Membrane Endothelial Keratoplasty (DMEK).

Photo by Ravali Modapu.

The Shantilal Shanghvi Cornea Institute (SSCI) operates one of the largest cornea services in the world, in this context. In 2022, 28 faculty handled over 110,000 patient visits in a year. Add to this our surgical volume volume of 21,000 surgeries, including over 3,300 corneal transplants a year and the magnitude of the opportunity we have begins to emerge. The Institute can now sift through these large patient datasets to see patterns where an intervention can improve patient outcomes. 50% of transplanted patients, for example, do not come to follow-up appointments a year after surgery. Follow-up care is critical for the success of one of the most storied interventions in corneal blindness, a transplant. So, how do we improve those follow-up numbers?

Similarly, 15% of our patients present with an infection in the eye – and over 50% first visit a rural centre. The most common corneal condition in a third-world, tropical setting is ocular surface disease accounting for over 30% of our patients, and corneal opacities – where the cornea is scarred or deformed due to an infection or accident – are the reason 25% of our patients seek medical care. What opportunities exist to improve outcomes in such cases?

The way forward

One of the key strengths of the Institute is our strong basic and clinical research legacy (you will read more about our work in this report). Our clinical and scientific teams encompass microbiology, visual psychophysics, and even stem cell research, genetics and molecular biology. We are well-placed then, to help build strategies for early detection of infection, identifying the organism, and prophylaxis—all before the infection worsens and requires surgery. While programs exist to tackle a small set of tropical infectious diseases (like trachoma), they are only the proverbial tip of the iceberg. A host of other tropical blinding conditions are truly neglected, and so, the Cornea Institute is one of the few places in the world with the onus and responsibility to tackle them.

Tropical low- and middle-income countries are all grappling with the same problems of corneal disease. So, the Institute will prioritise identifying and training doctors and support staff from these countries. Starting from 2022, we have begun to train young surgeons from other tropical countries to identify and manage such corneal conditions. Such international fellowships can multiply our impact and help us reach out to geographical areas we currently don't serve.

“We have been leveraging our large patient datasets and expertise in AI to build predictive models for disease outcomes.”

People alone cannot tackle the burden of global corneal impairment. They will need the aid of appropriate technologies and the new generation of AI and deep learning systems to deliver care. SSCI benefits from LVPEI's long-standing investment in technology and innovation. Ranging from low-cost products and spares to practice platforms for trainee surgeons, we have a strong engineering vertical in the Centre for Technology and Innovation at LVPEI. It is not just tools and devices, we have been leveraging our large patient datasets and expertise in AI and deep learning algorithms to build predictive models for disease outcomes. In 2022, I am encouraged to see the progress we have made with the keratoplasty outcome model and an algorithm that predicts keratoconus progression in patients – do read our section on innovation for more. I am delighted that these technologies are based on south Asian populations and can benefit them in the future.

Eye banking and the future of transplants

The Shantilal Shanghvi Cornea Institute's eye bank network is the bed rock of our success. Spread across southern and eastern India, the four eye banks collect over 10,000 corneas every year. Since its inception, the Ramayamma International Eye Bank has produced over 500,000 vials of corneal preservation medium (the MK medium). Thanks to their success, transplant patients of the Shantilal Shanghvi Cornea Institute do not have to wait for a donor cornea. But what happens after a corneal transplant? How do we ensure that the 50% of the Cornea Institute's transplant patients who are currently dropping out of care, don't?

Here lies the challenge, and the opportunity. We are building systems to educate patients about the need for follow-up care, to ensure compliance with medication and be able to provide them with affordable and easily accessible care. Our investments in teleophthalmology mean that follow-up can happen closer to the patient's homes. Our app, 'Grabi', can relay good-quality images off smartphones, to specialists who can plan treatment.

In this report, you will see that we have put the disruptions of the pandemic behind us. Across teams, we are working to refine and improve patient outcomes. We remain the best place to understand a variety of corneal conditions and provide a keen atmosphere for peers to share ideas. I must thank the Shantilal Shanghvi Foundation for supporting our work at this crucial juncture and we are delighted that we can name our institute of excellence after them. I look forward to what the future has to offer and the opportunities to make an impact.

"How do we ensure that the 50% of SSCI's transplant patients do not drop out of care?"

Pravin K Vaddavalli
Director, The Shantilal Shanghvi Cornea Institute

Pravin K Vaddavalli. Photo by Naga Satish.

The Shanghvi family at the Inauguration.

Photo by 'Rasta'.

The Shantilal Shanghvi Cornea Institute

On 12 November 2022, The Cornea Institute formally became the Shantilal Shanghvi Cornea Institute. With generous support from Mr Dilip Shanghvi and the Shantilal Shanghvi Foundation, SSCI took on its new name as the staff and the Shanghvi family came together that day. The inauguration was marked by Mr N V Ramana, retired Chief Justice of the Supreme Court of India, and Prof Partha Pratim Majumdar, National Science Chair, the Government of India.

The Shantilal Shanghvi Cornea Institute will be an Institute of Excellence, a Global Resource Centre that will work towards impacting all the key causes and forms of corneal impairment and blindness in the world. It will be a major resource for capacity building and make a sizeable contribution to the quality of care and its access. SSCI will do this by helping the development of cornea care facilities across the world that act as catalysts of change.

At the inauguration, Mr Dilip Shanghvi, Director of the Shantilal Shanghvi Foundation, said: 'We are happy to partner with LVPEI and support them in their endeavour to manage corneal blindness and help patients with improved vision and an improved quality of life.' Dr Pravin Vaddavalli, Director of the Shantilal Shanghvi Cornea Institute, said: 'The focus of the Shantilal Shanghvi Cornea Institute will be to make appropriate treatment available for eye problems resulting from corneal diseases. Envisaged as a Global Resource Centre, it will not only focus on caring for patients at all levels of eye care but also on creating and disseminating knowledge directly through the LVPEI network and indirectly by partnerships and capacity building of other eye healthcare organisations.'

Clinical care

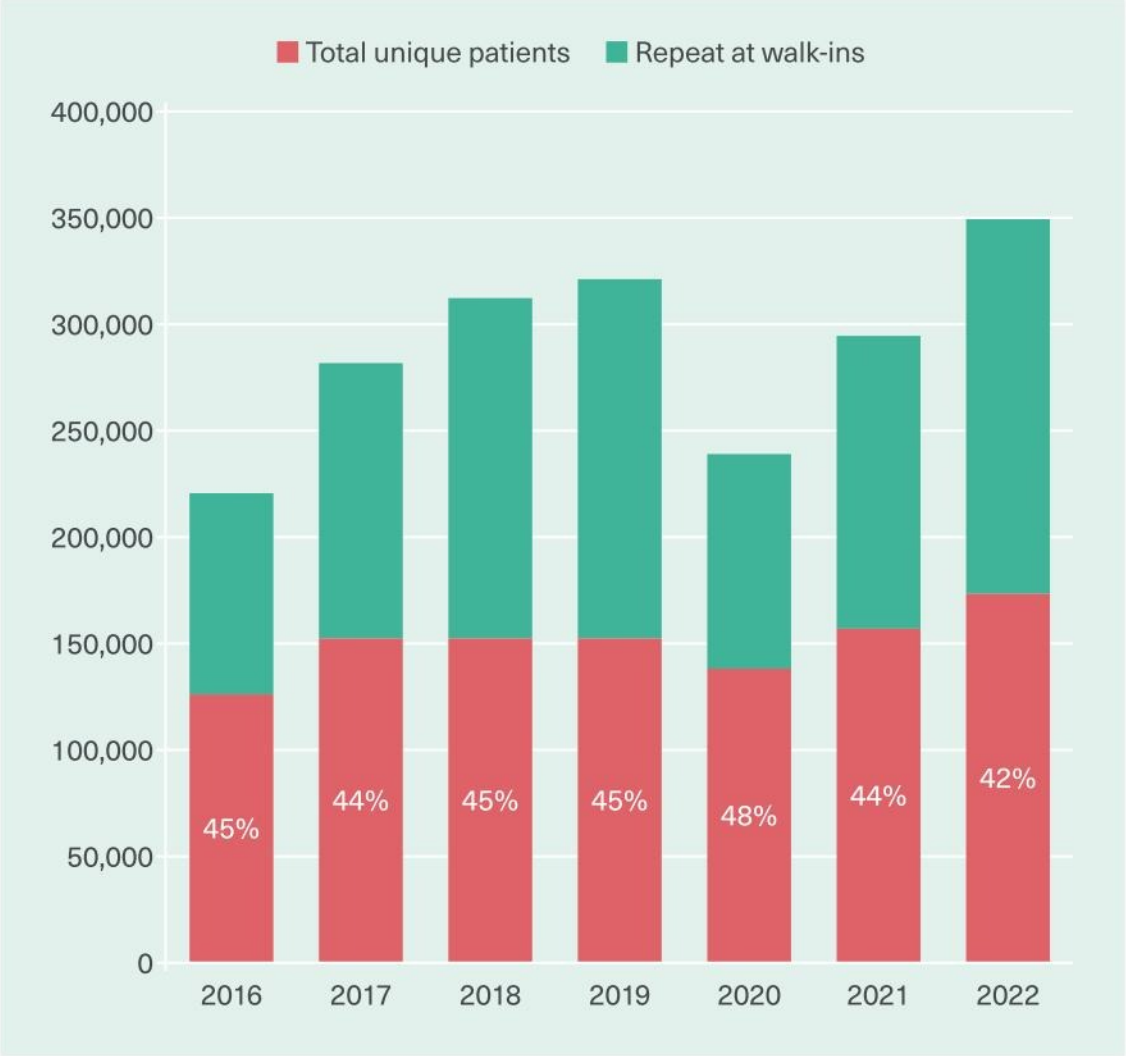
The Shantilal Shanghvi Cornea Institute runs one of the largest cornea departments in the world. By bringing together all the different cornea outpatient and surgery teams across the L V Prasad Eye Institute network, SSCI manages a high-volume, high-quality cornea service. Patients with a range of corneal conditions walk into our centres across Hyderabad, Bhubaneswar, Visakhapatnam, and Vijayawada every day for care. In addition, as part of SSCI's commitment to take care closer to our patients, several secondary centres across three Indian states too offer corneal services. Many of our world-class ophthalmologists travel to these locations, and our teleophthalmology command centre offers daily support across the LVPEI referral chain.

The year 2022 has been the first year out of the pall of the COVID-19 pandemic. SSCI saw over 340,000 patients walking into our clinics through the year. Of these about 141,000 – or two out of five patients – were unique visits (see table below). The difference also averages to about 3 visits in a year per patient. This ratio has implications for follow-up, especially for corneal transplantees who need multiple follow-ups and long-term care to ensure a successful graft (you will read more in the report). In 2022, SSCI serviced slightly more men than women; about 46% of our patients are women. This broad fraction has remained steady

A happy patient at our Secondary Centre in Mudhole, Telangana.

Photo by Srinivas Marmamula.

Figure 1 Total walk-ins vs. unique patients



over the years and closing the gap will require careful planning. Around the world, about 55% of people with vision loss are women and girls, reflecting barriers to access and general age longevity. Likewise, children too need clinical care, but the overall burden of corneal conditions is lower in children when compared to other causes of vision loss (such as myopia). So, about 10% of our patients are children. This fraction too has remained steady over the years. Of the patients who visited us in 2022, close to 22% were offered our services free-of-cost, including surgery.

Pyramidal care

SSCI is committed to taking good quality eye care service delivery to patients who need it the most. All LVPEI secondary centres – 26 in 2022 – offered corneal services to our patients, including some surgeries. Between 2021 and 2022, the number of unique patients visiting our secondary centres went up by 20%. As with previous years, our 26 secondary centres handle the most patients, when compared to our tertiary centres in the three cities combined, or to the Centre of Excellence in Hyderabad. These secondary centres are in towns and in rural districts across the three states we operate in. Therefore, these patient numbers reflect the trust these centres have developed in these geographies.

"In 2022, SSCI serviced slightly more men than women; about 46% of our patients are women."

PATIENT STORY

Sharvan and Hasini

Sharvan was born on a hot summer day in May 2001. Quickly, his parents saw that his eyes were 'whitish'; there was something wrong with Sharvan's eyes. The family live in Achanta, a small village in west Godavari district on one of the distributaries of the river, Godavari. Achanta is over 500 kilometres from the hospital in Hyderabad that had a chance to save Sharvan's sight. Despite the distance, the parents decided to bring little Sharvan over to the L V Prasad Eye Institute. To do that, they would have to take a boat to cross the Godavari and reach the nearest train station, and then take a train to Hyderabad. The family would take this arduous journey for years.

Sharvan and Hasini.

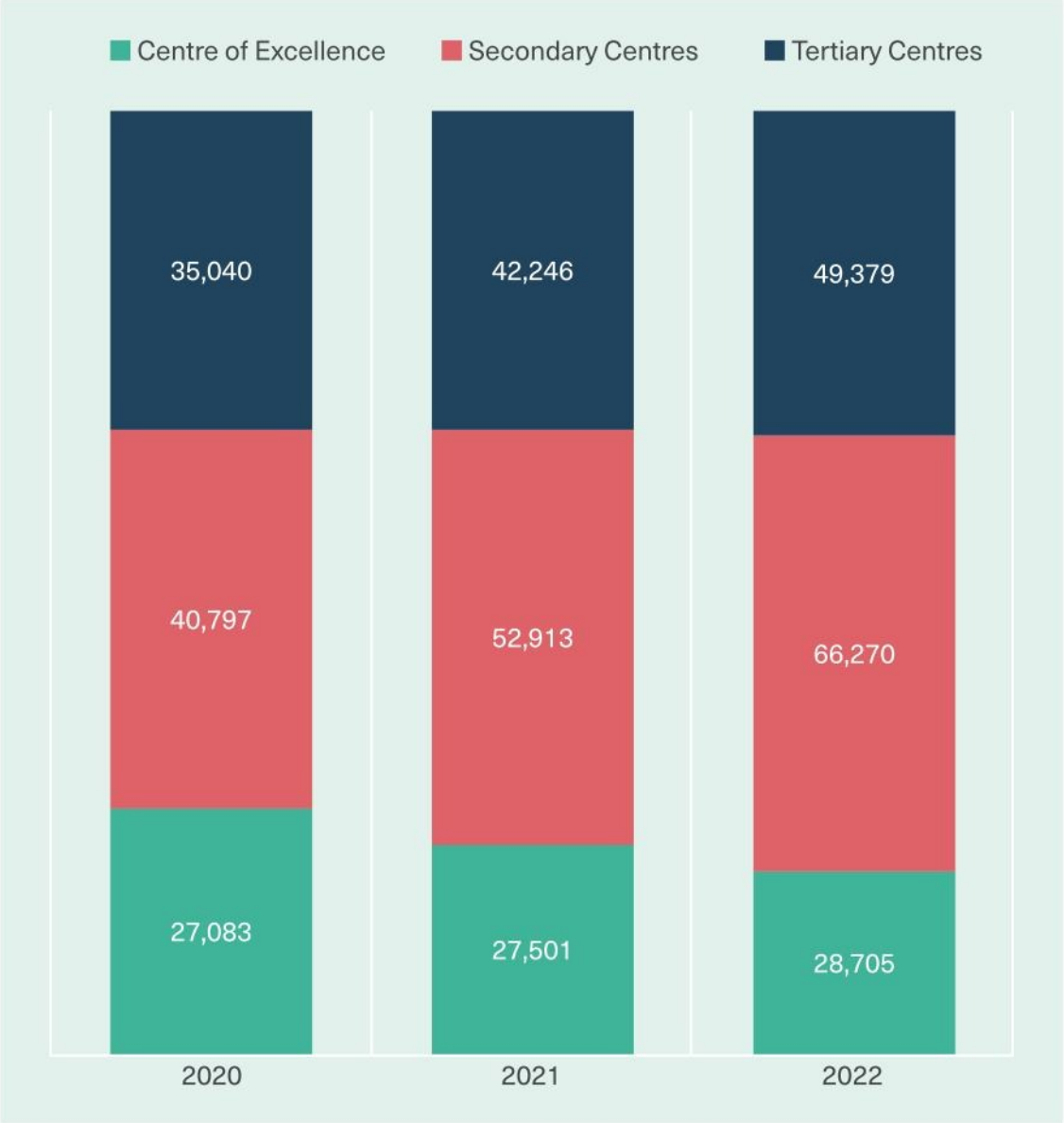
Illustration by Satwik Gade.

In 2003, when Sharvan came to LVPEI, the cornea team found corneal opacification in both his eyes. His only chance in those years was a full corneal transplant. But Sharvan was very young, and his eyes unstable. Over a period of 7 years, Sharvan needed 6 corneal transplants (The demand for corneas is acute around the world, however, LVPEI has a successful network of eye banks that has eliminated wait-lists – do read our Eye banking section). Despite their efforts, today he lost vision in one eye, and has partial vision in the other.

In 2007, Hasini, Sharvan's younger sister, was born. Their mother was distraught to find that her daughter's eyes had a similar abnormality. Hers was a consanguineous marriage, and the risk of congenital issues was high. However, the corneal specialists had learnt from Sharvan's experience; instead of a full corneal transplant, they only tried a partial opening. Today, the team at SSCI have a far better arsenal of techniques to tackle congenital corneal blindness (do see the Research section for more details).

Despite incredible odds, Sharvan and Hasini have managed to wrest their stories back into their hands. Sharvan, despite his developmental delays, is aspiring to finish his BA degree. Hasini will be writing her 10th class exams and gearing up for a new world of promise.

Figure 2 Outpatient visits (by centres)

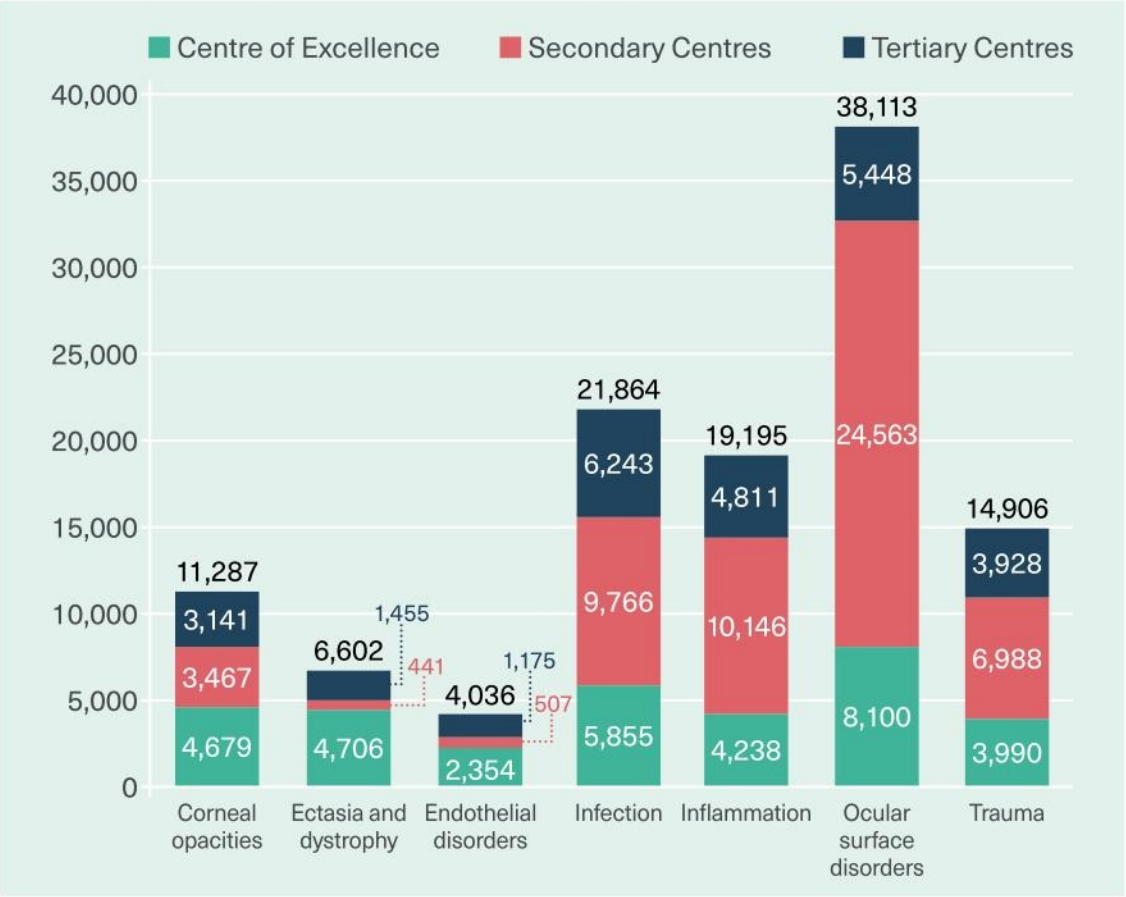


The secondary centres and a growing network of 'Vision' (primary) centres offer SSCI the best chance to ensure long-term follow-up for patients from these locations. One of the key issues for us to tackle is the percentage of patients who are lost to follow-up after a corneal transplant. While the reasons are complex, and SSCI is looking to understand this phenomenon, we do know that distance from the facility is a key barrier. Therefore, as the patronage for our primary and secondary centres increases, and they are empowered with teleophthalmology, they present a key site for mitigating loss to follow-up after a transplant.

A break-up of the key causes treated at these three pyramidal levels gives us insights into the kind of corneal disorders in the population and their location of choice for treatment. In the graph below, the burden of ocular surface disorders, inflammation and immune disorders, infection and trauma constitute nearly 80% of all the corneal disorders treated at SSCI's network of centres. In each of these conditions, it is the secondary centres that manage the most burden.

"These patient numbers reflect the trust these centres have developed in these geographies."

Figure 3 Patients by key conditions visiting our centres



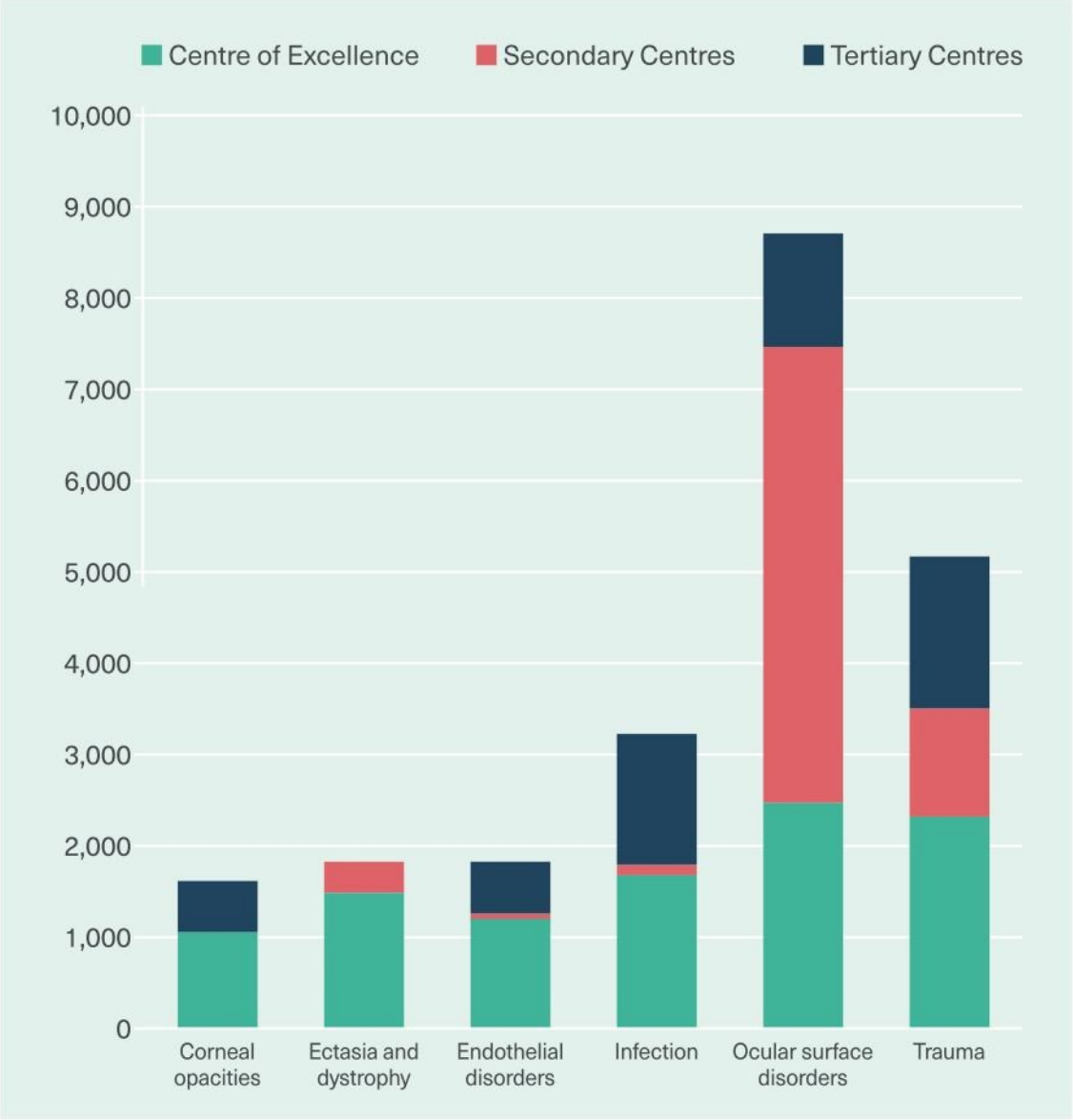
Surgeries and keratoplasties

However, the mainstay of SSCI's tertiary centres and the Centre of Excellence are the surgeries they perform to address corneal opacities and their causes.

SSCI performed over 20,000 surgeries in 2022, with the CoE accounting for nearly half of these interventions. Here too, most cases dealt with ocular surface disorders and trauma.

Doctors perform a keratoplasty. Photo by Ravali Modapu.

Figure 4 **Key surgeries by centre**

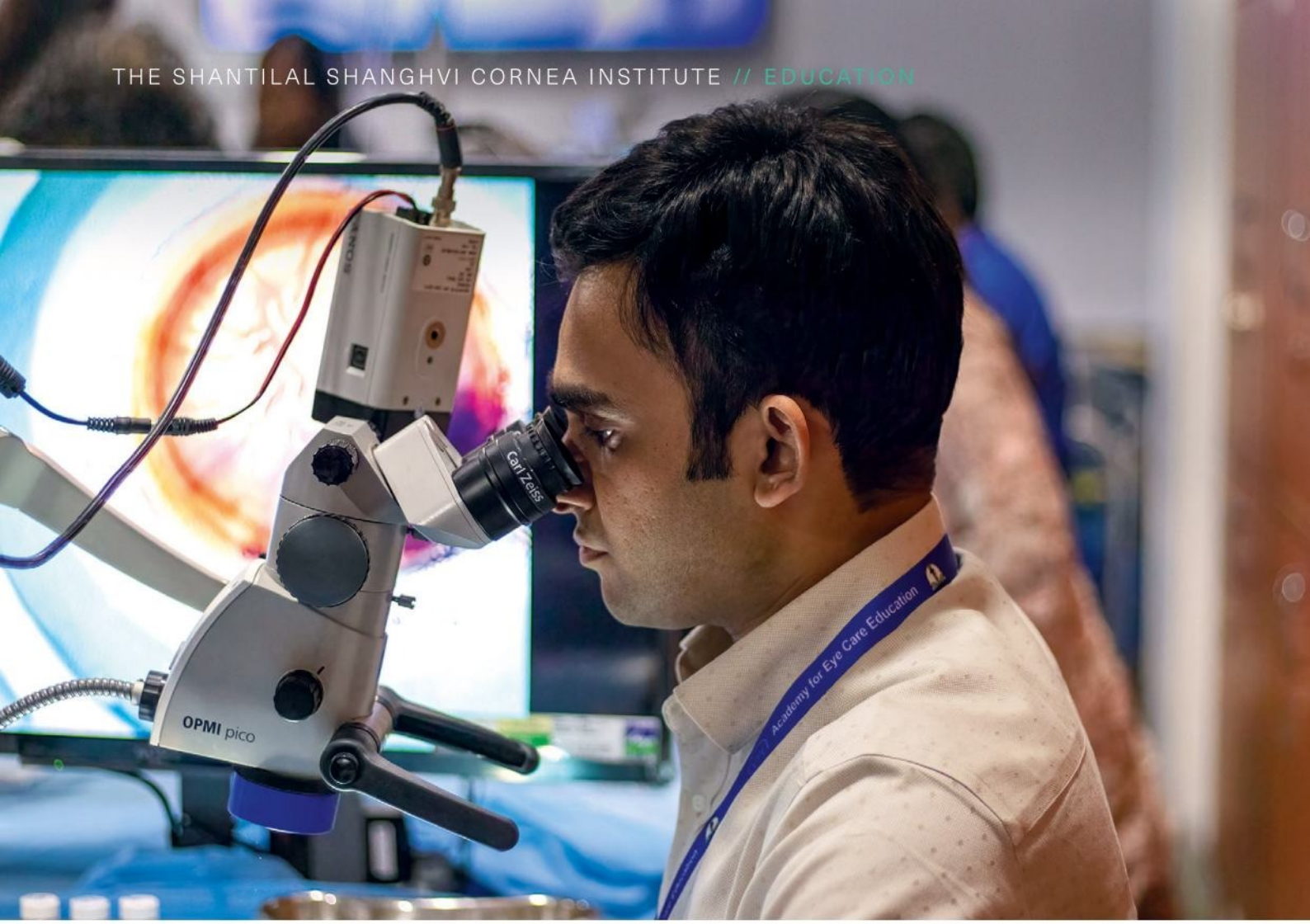


Keratoplasty

A wide variety of infectious and non-infectious causes lead to corneal blindness. In many cases, the most likely means of restoring vision, or arresting infection, is performing a keratoplasty. Today, the procedure has seen refinements across various dimensions: they are now minimally invasive and our surgeons are looking to move from suture to suture-less surgeries. Similarly, in 2022, the number of anterior and full thickness keratoplasties are coming down while layered surgeries are going up. For the past couple of years, the Descemet's membrane endothelial keratoplasty (DMEK) is going up because SSCI has been running training programmes to increase awareness.

Contact Lens

SSCI supplied over 14,000 contact lens prescriptions this year. SSCI is also keenly supporting the growth of specialty lens like scleral lens and PROSE. SSCI's contact lens clinics prescribe BostonSight scleral lens for several corneal conditions. As advanced corneal disease is increasing in the population, we believe that these specialty lenses can play a key role in offering non-surgical options.



Education

The Shantilal Shanghvi Cornea Institute directs efforts towards sharing knowledge and skills via the education activities which form one of its central pillars. Many of the best-name corneal surgeons trained in India, were trained at our cornea Institute over the years. This reflects the magnitude of impact the institute has had in shaping cornea education in the country. The various education programmes of SSCI amplify the institute's impact, reaching and benefitting patients beyond the Institute's clinics.

With high-volume clinics, state-of-the-art infrastructure, cutting edge technology and skilful cornea specialists on board, SSCI is an ideal environment for imparting these much-needed skills and knowledge. The SSCI Education team carries out these activities by training internal trainees, practising corneal surgeons, general ophthalmologists, residents, and optometrists. This is achieved primarily by its internal training opportunities through long term fellowship programmes, observerships and residency programmes. It also offers training to ophthalmologists and optometrists across the world through various Continuing Medical Education (CME) sessions, workshops, surgical masterclasses, and virtual training programmes.

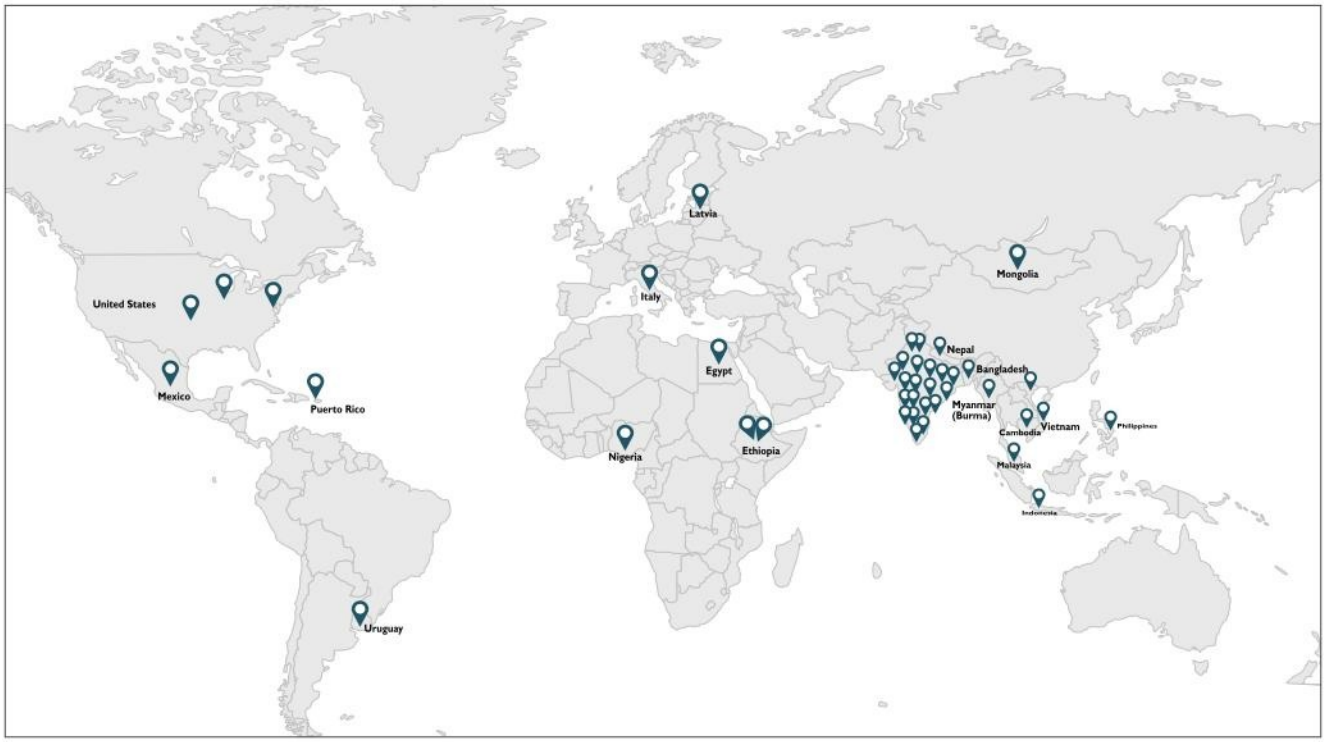
A Trainee at a DMEK workshop.
Photo by Ravali Modapu.

"SSCI is an ideal environment for imparting cutting-edge skills and knowledge."

Fellowships

The cornea fellowship programme has always been one of the highly coveted flagship programmes of the L V Prasad Eye Institute. It is a transformative experience that produces skilful cornea specialists irrespective of the level of skill at entry. The fellowship not just offers a great clinical and surgical exposure, but through its holistic approach, also nurtures its trainees to be doctors with a heart. It achieves this by instilling the institute's values and enables a flourishing interest in science through its academic training and research. The Institute's training is carried out through our long term and short term fellowship programmes, international fellowship programme, and observership programmes. With the various fellowship formats across the network, SSCI has trained over 400 trainees over the past few years. The impact of these fellowships transcends the country, touching the lives of many across the world. Our international fellowship programme also adds to these numbers by imparting skill, capacity building, and establishing collaborations.

Figure 5 Cornea Fellows from around the world



SSCI offers rigorous training through its well-structured and elaborate morning classes covering the entire bandwidth of corneal diseases. On average, two-three morning classes are run every week including theme-based case presentations, journal club discussions, video-based lectures and faculty lectures over the past year to ensure a streamlined learning experience for the trainees. The Institute continues to nurture its collaboration with the Cornea services of prestigious institutes like the Bascom Palmer Eye Institute, Miami, USA with combined case discussions that benefit the trainees of both institutes. In 2022, 11 Corneas fellows graduated from the Cornea fellowship programme.

"The Institute continues to nurture its collaboration with the Cornea services of prestigious global institutes."

Continuing education

SSCI also offers short duration training opportunities to practicing clinicians and optometrists around the world, through its CMEs and workshops. The 9th edition of the ocular surface workshop (OSW) was an academic success where key themes included surgical masterclasses, clinical training, wet-lab training and live surgeries. The workshop had numerous interactive sessions and brainstorming activities. The 'bug busters' conference on corneal infections is another popular academic workshop. As infections are a major cause of corneal interventions in low- and middle-income countries, 'Bug Busters' sees a lot of interest from corneal surgeons.

In 2022, we also conducted a unique corneal neurotization workshop that brings corneal surgeons, oculoplastic surgeons and head and neck surgeons together to expand clinical horizons and share knowledge on corneal innervation. Focussed skill transfer training sessions were a big theme in 2022, with targeted, smaller groups that attended our surgical masterclasses on Descemet Stripping Endothelial Keratoplasty (DSAEK), Descemet's membrane endothelial keratoplasty (DMEK) and ocular surface, facilitating one-on-one interaction for the participants. In fact, SSCI is one of the few institutes in the world that can teach a surgeon the DMEK.

The iCLEP programme saw increasing enthusiasts from the optometry group across the globe who came together to share knowledge and build skills. The eye bank technician training is yet another flagship programme of the cornea institute working towards sharing knowledge on eye banking.

Project ECHO

The project ECHO (Extension for Community Health Outcomes) model is a peer-to-peer learning framework with an "all teach, all learn" approach to sharing clinical expertise and experiences between medical experts. A typical ECHO session runs online and centres around experts presenting anonymized, real clinical cases. Specialists and attendees share clinical knowledge and advice, all of which enrich patient care practice. Such sessions can also benefit patients as their doctors can consult an expert online and avoid the need to travel to tertiary care centres. In partnership with ECHO India, SSCI is a major learning hub in ophthalmology for Southeast Asia.

"ECHO sessions can also benefit patients as their doctors can consult an expert online."

The Institute conducts weekly project ECHO sessions connecting alumni, residents, fellows, community ophthalmologists and optometrists across India and Southeast Asia the Middle East, and West Africa. The institute runs seven learning hubs: myopia, scleral contact lenses, microbial keratitis, refractive surgery, corneal transplants, and resident training. In 2022, we conducted 73 hours of teaching sessions, reaching out to 868 participants.

From Left to right: Ms Bidula Das (SSCI), Dr Aravind Roy (SSCI), Mr Sandeep Bhalla (Associate VP, ECHO) Mr Arun Selvaraj (Dy GM, ECHO) Ms Nidhi Shankar (Manager, Product management and IT, ECHO).

Table 1 SSCI ECHO 2022 Snapshot

	ECHO learning group	Number of Sessions	Active participants	Cases discussed	Female participation (%)
1	Myopia	7	169	7	56.2
2	Scleral contact lenses	4	97	2	49.4
3	Residents learning	21	150	13	80
4	Microbial keratitis	18	155	12	69
5	Cornea transplant	9	124	11	69.3
6	Refractive surgery	9	138	11	68.1

In 2022, the ECHO LVPEI Ophthalmology learning hub has increased awareness of rare clinical presentations to community-based physicians. One example is microbiology-assisted care of corneal infections leading to improved clinical outcomes.

The future

A fellowship opportunity at LVPEI is an opportunity to develop skills and independence in research, in surgeries, and in the clinic. On average we aim to get each fellow to perform 150-200 corneal transplants by the time they leave our doors. This means we have to reinvent our practice based on global trends.

The future looks bright with the efforts initiated to explore remote wet lab training for the trainees at our secondary centres. All the efforts of the education team from SSCI are directed towards achieving the prime mission of transforming our trainees to not just be successful practitioners, but effective teachers and academicians upon exit. The international fellowship programme is another initiative that helps us take this impact globally.

SSCI's education programs offer learning opportunities for the full spectrum of corneal conditions. A trainee ends the program becoming a good surgeon with a holistic experience.

Dr Pragnya Rao
Consultant ophthalmologist, Education Lead of The Shantilal Shanghvi Cornea Institute

Dr Kavya Chandran
Consultant ophthalmologist, Education Lead of The Shantilal Shanghvi Cornea Institute

Eye banking

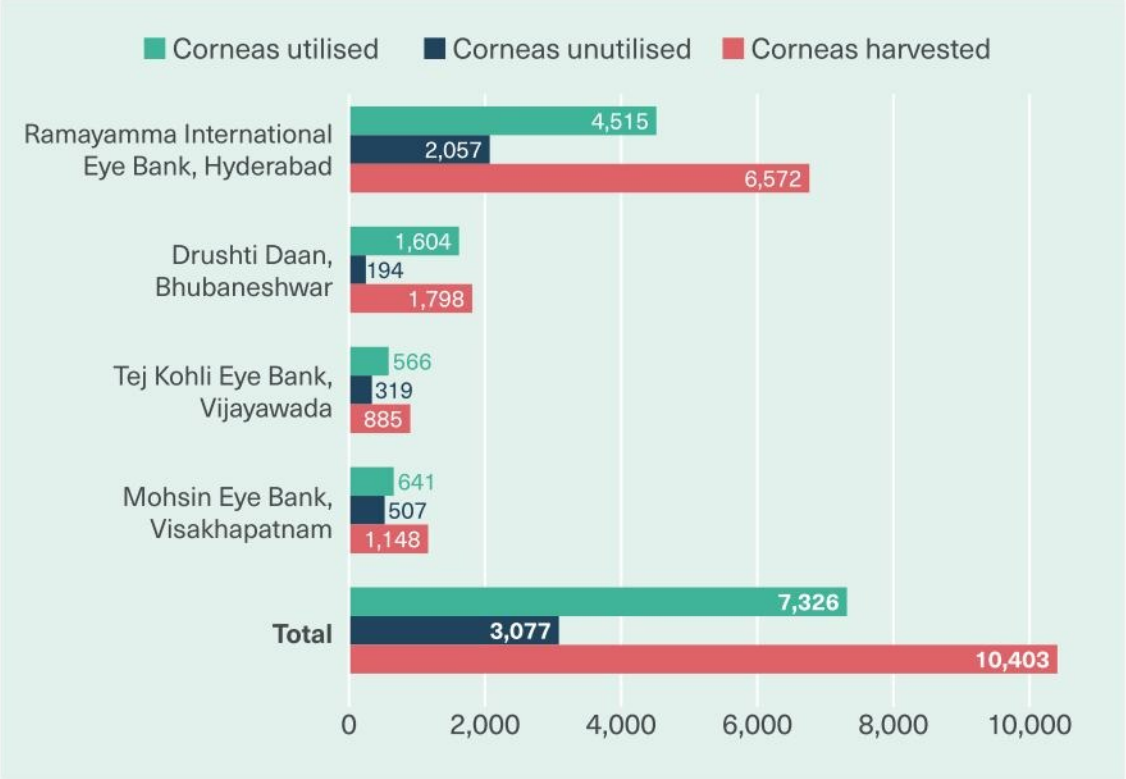
SCI is home to The Ramayamma International Eye Bank (RIEB), the largest provider of sight restoring corneas in India. Along with eye banks in the three tertiary care facilities in Bhubaneshwar, Vijayawada, and Visakhapatnam, RIEB constitutes the L V Prasad Eye Institute's eye banking network, which fall under SSCI. The network has harvested nearly 130,000 corneas since 1989.

The Ramayamma International Eye Bank (RIEB) is also the largest eye bank in Asia and one of the largest in the world. The LVPEI eye bank network of 4 eye banks and several eye collection centres, collecting more than 10,000 corneas each year and supplying close to 7,500 corneas for surgeries to a vast network of surgeons across the country.

A technician checking a cornea stored in a preservation medium.

Photo by Naga Satish.

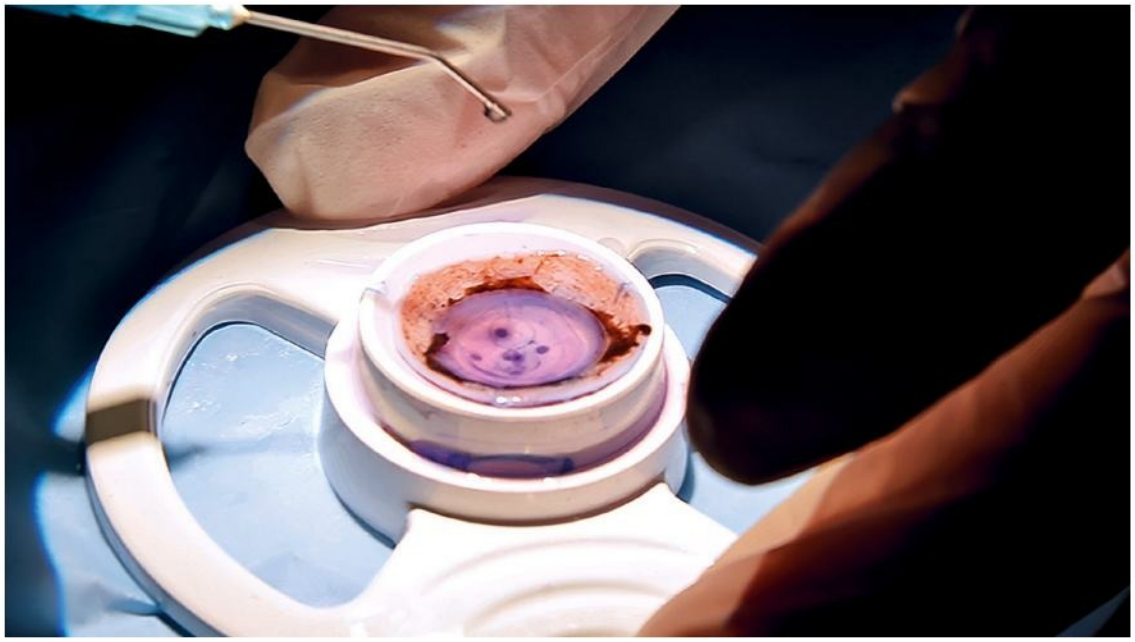
Figure 6 Corneas Utilised: From April 2022 to March 2023



Advanced surgical techniques

The eye bank network strives to keep pace with advancements in corneal surgical techniques. We prepare and supply partial thickness tissues, for example, for an advanced and recently introduced technique of cornea transplantation. In 2022, our eye bank technicians began to process and distribute pre-prepared tissue for Descemet's membrane endothelial keratoplasty (DMEK). This is an important step in selective partial thickness keratoplasty—and a task hitherto limited to surgeons. So far, 200 pre-prepared tissues at the eye bank have been utilized by surgeons.

"The eye bank network strives to keep pace with advancements in corneal surgical techniques."



Corneal tissue for DMEK.

Photo by Ravali Modapu.

Celebrations

The Drushti Daan eye bank in Bhubaneshwar celebrated its twentieth anniversary on September 3, 2022 with a commemorative book released by the Governor of Odisha, Prof. Ganeshi Lal. An MoU was also signed between the DDEB and the District Headquarters Hospital, Kendrapara, bringing eight districts in Odisha into our cornea harvesting network.

Our network continues to grow with the establishment of an eye bank at a government institute in Varanasi: the Regional Institute of Ophthalmology, Institute of Medical Sciences, Banaras Hindu University. A collaborative initiative between The Hans Foundation, TATA Trusts, and the L V Prasad Eye Institute's Eye bank network, this new centre aims to achieve zero waiting for corneal transplant surgeries in the region, at the heart of Uttar Pradesh, India's most populous state.

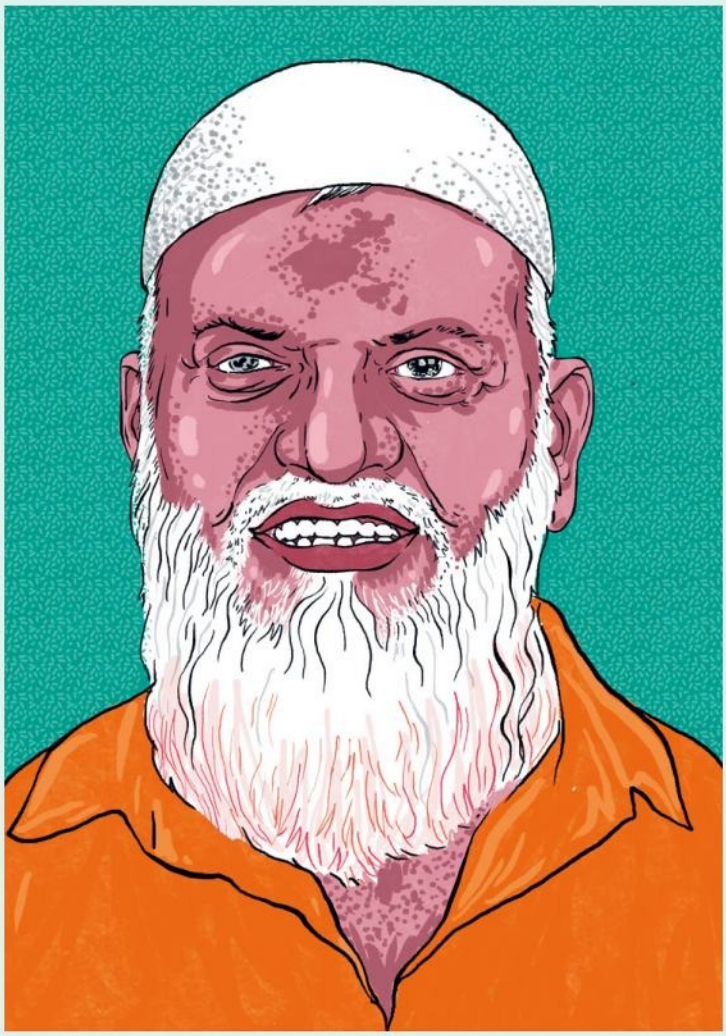
The feather on the cap has to be the Global Alliance of Eye Bank Associations' (GAEBA) ***Inaugural National Award*** in recognition of our well-established eye bank network and our efforts towards eye banking and addressing corneal blindness in the country. This award, dedicated to celebrating the achievements of the eye bank sector, was announced at the World Eye Bank Symposium in July 2022.

Dr Sujata Das
Consultant ophthalmologist, Eye Bank Lead of the Shantilal Shanghvi Cornea Institute

Dr Sunita Chaurasia
Consultant ophthalmologist, Eye Bank Lead for the Ramayamma International Eye Bank

PATIENT STORY

Khaja Pasha



Khaja Syed Pasha.

Illustration by Satwik Gade.

Monkeys. A troop of monkeys had descended on Syed Khaja Pasha's house one morning in August 2021. Khaja Pasha, an autorickshaw driver, lives in Ghatkesar on the outskirts of Hyderabad. That day, his daughter was getting married, Syed Pasha had his hands full, and the monkeys were not helping. Monkeys were a constant menace in Ghatkesar, and so, Khaja Pasha used a Carbide 'gun' to scare them away. Many communities have taken up home-brew contraptions with PVC pipes and Calcium Carbide, to fashion a 'gun', which is ignited to make a big sound. The blast scares the monkeys away. But the *jugaad* is risky—sometimes, the carbide does not light up, or there is a delay.

That day, there was a delay. Khaja Pasha peeked into the cylinder to see if there was an obstruction—and the gun fired. The chemical flew up and burnt his right eye grievously. After shifting him around, Khaja Pasha was brought into SSCI's cornea facilities for urgent attention. He was given an eye wash, but the chemical had burnt away precious tissue. Amniotic membrane from fetal placenta can help heal deadly injuries of the eye, especially chemical injuries. SSCI's eye bank is one of the few centres in the world that processes and supplies amniotic membrane tissue for such injuries and ocular procedures. In September 2021, Khaja Pasha got an amniotic membrane transplant. However, Khaja Pasha's injury had left his right eye bereft of stem cells that could rejuvenate the damaged ocular tissue. The membrane was not enough.

LVPEI developed the Simple limbal epithelial transplantation (SLET), a technique that involves a biopsy of healthy tissue from a normal eye, which is then used to 'seed' healthy limbal cells in the damaged one. In October 2021, Khaja Pasha underwent SLET as well. Finally, another key innovation at LVPEI offered Khaja Pasha relief: Scleral lens. Scleral lenses are specialised, large diameter contact lens that 'sit' on the whites of the eye. They also house a saline solution that helps soothe the damaged eye.

Today, with those lenses on, and with a modicum of vision in his right eye, Khaja Pasha is back to plying his autorickshaw.

Research

The Shantilal Shanghvi Cornea Institute is uniquely placed to address key questions in the aetiology, diagnosis and cure of a range of corneal diseases and disorders. The institute's clinicians and scientists have a global reputation for their contributions to scientific literature on the cornea. In fact, our unique location within a tertiary network of eye hospitals in a tropical, third-world setting allows us to practice world-class science in the service of some of the poorest and most under-served populations in the world.

Our endeavour is to help improve patient outcomes, as most of our research is focused on trying to find solutions that makes a difference to a patient's vision and their quality of life. SSCI's 28 consultants work on different aspects of corneal research, including the unique digital data records of patients that our network produces. These consultants work from three tertiary centres across southern and south-east India, which connect to our extensive research facilities at the Centre of Excellence in Hyderabad, Telangana.

Photo by Ravali Modapu.

Areas of focus

Many things can go awry with the cornea. The most common form of disease is a corneal infection, though a new set of conditions that affect the ocular surface are on the rise. Ectasias, characterised by a thinning cornea, also present regularly at SSCI's clinics. Though rare, many congenital, paediatric conditions too are referred to our specialists. SSCI's consultants routinely perform keratoplasties, or a corneal

"Our endeavour is to help improve patient outcomes, and find solutions that makes a difference to a patient's vision and their quality of life."

transplantation, to treat corneal blindness – this is the primary surgical intervention on offer at a tertiary level care centre. However, there are several risks that come with transplantation – infection, rejection of the transplanted cornea, secondary increase in intra-ocular pressure – that reduces the longevity of the transplant. Many recipients will then require a second corneal transplantation. There is also always a demand-supply mismatch with the number of patients requiring a corneal transplantation exceeding the number of corneas available. These concerns are at the centre of the broad areas of research focus at SSCI: corneal infections, ocular surface diseases, corneal ectasias, paediatric interventions, various keratoplasties and their enhancements, and ultimately the longevity and health of a transplanted cornea.

Corneal infections

Corneal infections, or infectious keratitis, are one of the most common indications for a patient to visit a cornea specialist. These are emergencies which need urgent treatment. When treated early, many eyes may eventually develop a corneal scar necessitating a keratoplasty. When not treated early, they may progress to become corneal infections that are unresponsive to treatment, or cause complications such as a corneal perforation, thus requiring an urgent keratoplasty. The outcomes of corneal transplantation in advanced corneal infections are not very promising. Therefore, treating corneal infections *before* surgical intervention is required becomes critical. SSCI's clinicians, led by Dr Bhupesh Bagga, have been working on various aspects of microbial keratitis. At SSCI, the teams are studying modalities such as 'Rose Bengal' (a staining agent) mediated photodynamic antimicrobial therapy (PDAT) to reduce the infection load in corneas, reducing the need for a transplant.

Corneal infections are common in rural, agricultural settings, but are difficult to diagnose without ancillary tests that may not be available in such locations. So, a large number of cases that reach a specialist are difficult to manage with medical treatment alone and will need surgery. Corneal injuries with vegetative matter or soil contamination can infect the surface layers with bacteria, fungi like *aspergillus* and *fusarium*, or fungus-like microbes *Pythium insidiosum* that don't respond to anti-fungals. In fact, organisms like Pythium are neglected causes of corneal infection—they have been poorly studied, and their treatment is inadequately explored.

"Treating corneal infections *before* surgical intervention is required becomes critical."

Pythium is a difficult organism to identify and treat. SSCI researchers have made multiple advances over the last few years, and have identified modalities for early diagnosis of pythium infections. They are investigating antibiotics that treat this infection, and the overall outcomes of corneal infections caused by this species has improved. In 2022, researchers conducted randomised controlled trials to understand the efficacy of two different treatment regimens in a group of patients with pythium keratitis. The way forward is to improve modalities for earlier

Bagga B, Sharma S, Ahirwar LK, Sheba E, Vaddavalli PK, Mishra DK. Clinical Outcomes of Rose Bengal Mediated Photodynamic Antimicrobial Therapy on Fungal Keratitis with Their Microbiological and Pathological Correlation. Curr Eye Res. 2022 Jul;47(7):987–994.

Vishwakarma P, Bagga B. Pythium insidiosum keratitis: Review of literature of 5 years' clinical experience at a tertiary eye care center. Semin Ophthalmol. 2023 Feb;38(2):190–200.

"Pythium infections affect poor, agricultural workers in developing countries, and so, have remained unexamined for decades. Our work has implications for the treatment of ocular infections due to Pythium across the developing world."

Dr Bhupesh Bagga, head of The Ramoji Foundation Centre for Corneal Infections, Shantilal Shanghvi Cornea Institute, LVPEI

diagnosis of corneal infections, find newer avenues in the form of molecules and drugs to improve medical management of corneal infections, to find ways to increase penetration through the cornea of existing drugs to reduce the infectious load, and to improve outcomes of corneal transplantation in these eyes.

Abrasions

Corneal abrasions are superficial scratches of the cornea's topmost layer, the corneal epithelium that occur following trauma. If not diagnosed and managed early, abrasions can become corneal infections, form a corneal scar after healing, or end up needing a corneal transplantation. Early management of corneal abrasions is the key to prevent vision-threatening complications – and a study from 2022 by Dr Varsha Rathi and her colleagues show how valuable that is. Corneal abrasions that are treated early saves the eye – and time and money for patients who live far away from urban centres. Delayed presentation results in advanced disease leading to poor clinical and economic outcomes, thus increasing the cost to both the patient and the healthcare system. If these corneal abrasions are managed as soon as they happen at local health care centres in rural areas, this could prevent disease progression and could reduce the burden on the health care system, also reducing the cost to the patient. The study makes the case for the value of the vision centre model in ensuring local access, and spreading the message that seeking early care for a corneal abrasion could prevent the need for expensive treatment.

Eye banking

Fundamental to the possibility of a keratoplasty is a donor cornea. The Ramayamma International Eye bank (RIEB) at LVPEI is the largest eyebank in Asia and one of the largest in the world. RIEB is responsible for collecting and processing donor corneas, and for distributing them to corneal graft surgeons for corneal transplantation.

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Roy A, Jeng BH, Chaurasia S, Das S. Overview of Short-Term and Intermediate-Term Corneal Storage Solution: Comparison of Clinical Outcomes and Need For Future Research. Eye Contact Lens. 2022 Apr 1;48(4):141-148.

Tanna V, Bagga B, Sharma S, Ahirwar LK, Kate A, Mohamed A, Joseph J. Randomized Double-Masked Placebo-Controlled Trial for the Management of Pythium Keratitis: Combination of Antibiotics Versus Monotherapy. Cornea. 2023 Feb 14.

Sushmasri K, Joseph J, Chaurasia SR, Ramachandran C, Roy S. An experimental study to evaluate the effect of polymixin E (Colistin) alone or in combination with gentamicin in McCarey-Kaufman corneal preservation medium on various drug resistant bacterial and fungal isolates. Indian J Ophthalmol. 2022 Aug;70(8):2950-2955.

Donor corneas for corneal transplantation are a scarce resource and these need to be preserved in preservative media as the shelf life of these corneas is short. The M-K (McCarey-Kaufman) medium is used to store corneas, but this has a shelf life of 3–5 days, after which the donor cornea may not be viable.

Research in this area, then, focuses on trying to find better ways to prolong the longevity of corneas before transplantation, thus enabling to widen the pool of available corneas. At the same time, these corneas should be completely sterile after transplantation thus preventing donor-cornea related infections in the recipient eye. The eye bank team at SSCI, led by Dr Sujata Das, are working on supplementing the corneal preservative media with antibiotics and antifungals to reduce contamination. The goal of this research is to reduce post-operative infections in the transplanted corneas, thus increasing the longevity of these corneas. They are currently working on safety profiles of various antibiotics and anti-fungals and their goal is to work on new preservative media to improve the shelf life of donor corneas.

Pediatric Cornea

Dr Muralidhar Ramappa and his team specialise in treating pediatric corneal disorders, which are rare and complex conditions that require specialised expertise for accurate diagnosis and effective management. The team's research focuses on enhancing the diagnosis, treatment, and surgical outcomes of several congenital disorders. One of their key research areas is the development of a less invasive procedure called Selective Endothelialectomy for Peters Anomaly (SEPA), which aims to minimize complications related to full-thickness corneal transplantation in children.SEPA has shown promising long-term outcomes and could significantly improve children's lives. The development of modalities such as SEPA is important because full-thickness corneal transplantation in children has a high rate of failure with increased chances of rejection of the transplanted cornea. If the visual axis is not cleared at a young age,

"The development of modalities such as SEPA is important because full-thickness corneal transplantation in children has a high rate of failure."

Dr Muralidhar with his patient from Bangladesh.

Photo by Muralidhar Ramappa.

Ramappa M, Chaurasia S, Mohamed A, Ramya Achanta DS, Mandal AK, Edward DP, Gokhale N, Swarup R, Nischal KK. Selective Endothelialectomy in Peters Anomaly: A Novel Surgical Technique and Its Clinical Outcomes in Children. Cornea. 2022 Dec 1;41(12):1477-1486.

Tavakkoli F, Damala M, Koduri MA, Gangadharan A, Rai AK, Dash D, Basu S, Singh V. Transcriptomic Profiling of Human Limbus-Derived Stromal/Mesenchymal Stem Cells-Novel Mechanistic Insights into the Pathways Involved in Corneal Wound Healing. Int J Mol Sci. 2022 Jul 26;23(15):8226

the window of opportunity to provide stimulation for development for the neural pathways for vision is lost, thus causing permanent blindness which cannot be corrected at a later age. Being able to avoid a full-thickness corneal transplantation and still allowing clearance of the visual axis by techniques such as SEPA is revolutionary. The researchers are also working on the potential of the CRISPR-Cas9 system in treating monogenic corneal endothelial disorders by targeting and modifying the mutated gene responsible for congenital hereditary endothelial dystrophy (CHED) which is a genetic condition causing corneal blindness in children. Dr Ramappa's team is dedicated to pushing the boundaries of knowledge in pediatric corneal disorders and improving patient outcomes through their research and surgical innovations.

Corneal Scars

At present, the only modality of treatment for corneal scars is a corneal transplant. The researchers at SSCI led by Dr Sayan Basu, and basic scientist, Dr Vivek Singh, are working on another exciting area of harnessing the power of mesenchymal corneal stromal cells to heal corneal scars. This minimally invasive surgical modality could go a long way in improving vision of patients with corneal scars, thus preventing the need for a corneal transplantation.

Ocular Surface

Ocular surface diseases are a group of conditions that can cause life-long suffering and progressive damage to vision causing bilateral corneal blindness. These cases, if not diagnosed on time, may lead to corneal damage in the form of corneal scars. In many such eyes, keratoplasty may not be amenable due to associated dry eye disease. Hence, early diagnosis, adequate and appropriate management is the key to avoid vision threatening sequelae, necessitating keratoplasty. The clinicians working on the focus area of ocular surface, led by Dr Sayan Basu, have been working on various aspects of ocular surface diseases such as dry eye disease, ocular burns, Stevens-Johnson syndrome, ocular mucous membrane pemphigoid, and ocular allergy. The team have been working on improving algorithms establishing the diagnosis in these eyes, enabling appropriate treatment.

"The team is working on understanding the risk factors for vision-threatening events in patients with severe dry eye."

They have also worked on establishing treatment protocols in these eyes, thus going one step further in trying to improve the outcomes of management in these complex eyes. Another dimension this group has been working on is continually improving the functional

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Singh S, Donthineni PR, Shanbhag SS, Senthil S, Ong HS, Dart JK, Basu S. Drug induced cicatrizing conjunctivitis: A case series with review of etiopathogenesis, diagnosis and management. Ocul Surf. 2022 Apr;24:83-92.

Kate A, Doctor MB, Basu S. Drug-induced pemphigoid: Clinical presentation, diagnosis, and management of gliptin- associated cicatrizing conjunctivitis. Ocul Surf. 2022 Oct;26:50-52.

outcomes of a surgical intervention called simple limbal epithelial transplantation (SLET) which was first described at LVPEI in 2011. This surgery is performed for loss of limbal epithelial stem cells in the eye, most commonly by ocular burn. The team has published on the use of contact lenses post SLET to improve visual outcomes, thus obviating the need for a corneal transplantation. In the area of dry eye disease, the team is working on understanding the risk factors for vision-threatening events in patients with severe dry eye. They are also trying to come up with more avenues to improve the level of tears in eyes with dry eye disease in the form of salivary gland transplantation and are hoping to understand if lacrimal gland (which is the main source for tears in the eye) regeneration is a possibility in the future. The focus of this team in the future is also going to be on prevention of certain ocular surface diseases such as ocular burns in the form of chuna injuries and ocular sequelae of Stevens-Johnson syndrome, thus going a long way in trying to reduce corneal blindness due to these preventable conditions.

Corneal ectasia

Corneal ectasias are a group of disorders where the cornea gradually gets thinner and starts bulging forward thus leading to blurry vision. The team of clinicians working in the area of corneal ectasia, led by Dr Pravin Krishna Vaddavalli, is working on understanding the burden of the problem first. They have studied the evolution of the diagnosis of corneal ectasia and management in the past 30 years. They are also trying to understand the trends in practicing patterns by ophthalmologists across the country for management of the most prevalent corneal ectasia, Keratoconus. They are also working on understanding the different risk factors for progression of keratoconus and the risk factors for failure of surgical interventions. They are trying to understand if an artificial intelligence model will help in predicting the probability of progression of keratoconus. Further scope of research includes exploring the use of different human or bioengineered tissues for volume replacement in such eyes with thin corneas, establishing treatment protocols for surgical interventions in advanced keratoconus to prevent further progression, and working on an experimental model of corneal ectasia to developing newer management techniques, especially techniques of volume replacement, and newer protocols for prevention of progression for corneal ectasias.

Dr Swapna Shanbhag
Consultant ophthalmologist, Research Lead of the Shantilal Shanghvi Cornea Institute

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PATIENT STORY

Sushmita

Sushmita.
Illustration by Satwik Gade

Sushmita rolls beedis for a living in a small village in Nirmal district of Telangana. Her 11-year-old daughter lives away from her, studying in a hostel. Summer holidays were on, and it was time to get her daughter home. The day Sushmita and her daughter came home, she sat down to make lunch for them. But something was wrong – Sushmita's right eye was tearing up. The tears wouldn't stop, and she was in a lot of pain. After seeking help in Nirmal, she was referred to our secondary centre in Mudhole. There, Sushmita was diagnosed with a corneal infection. Secondary centres are key nodes in the LVPEI pyramid: 15% of all SSCI patients present with infections, but 50% appear first in a rural, secondary centre.

Sushmita was in a world of pain and tears. She had picked up a strange organism, a Pythium. Human pythiosis is similar to fungal infections—but anti-fungals have no effect on such infections. All the treatment modalities currently in use for pythium infections around the world were first described at LVPEI. However, it meant that Sushmita had to travel to Hyderabad for her treatment. Despite free treatment, the costs were too much for her. There were days when she had no money to head back to her village. Sushmita would find work at the bus station till she made enough money to go back home.

Soon enough, she gave up taking her medicine; and finally, Sushmita needed a corneal transplant.

Sushmita professes deep gratitude for the team of surgeons and technicians who did their best for her. After all these interventions, Sushmita cannot see with her right eye. But Sushmita is now free of ocular pain and tearing, and is back to work.

There is hope.

Innovation

Technology and Innovation will play a crucial role in the future of cornea care. In the last year, the Shantilal Shanghvi Cornea Institute has made significant strides in this area. One of our first products, the Corneal preservation medium (MK medium) was developed way back in 1994, and since then the Ramayamma International Eye Bank has manufactured and distributed more than 500,000 vials of MK media across the country and internationally. Last year saw the production and distribution of over 21,000 vials of this crucial medium across the country.

Product Engineering

The artificial anterior chamber and Teflon blocks manufactured in-house by the engineering team and used by surgeons to practice and perform partial thickness corneal transplant surgeries are an example of low-cost, high-impact products that come out of our Innovation centre.

In the area of imaging, we were able to empower our Vision Centres with a modular attachment that connected tablets to the slit lamp, an essential device for eye screening that you find in all eye exam rooms. The module enabled

Using a Grabi™ device.

Photo by Ravali Modapu.

the capture of good quality images of the front of the patient's eye. Then the Vision Technician could seek a teleconsultation opinion from a physician in a tertiary centre – revolutionising access to support and insight in rural settings. Last year, we saw over 60,000 such consults from rural vision centres, potentially saving an estimated 3.5 million kilometres of travel for patients presenting to tertiary care facilities.

Grabi™

Another novel addition to the teleconsultation process of patients with corneal disease, is the 'Grabi' Device. This simple device hooks on to any mobile phone with a camera. Coupled with a smartphone app, Grabi assists in the capture of a clean, exam-worthy photograph of the front of the eye by the patient themselves or their attendant. This image, when shared with the cornea specialist, is good enough in over 75% of instances for doctors to advise treatment. Grabi provides the revolutionary choice of a follow-up online consultation for patients from the comfort of their homes. In 2022, 561 patients received this device, and we aim to expand this number to every corneal transplant patient we care for at SSCI.

Data Futures

In addition, last year we digitized the corneal transplant data of 28,000 transplants and utilising cutting-edge technologies like Deep Learning and Machine Learning we are trying to build assistive AI modules on scalable platforms to help with decision-making for patients undergoing corneal transplants.

"Technology and Innovation will play a crucial role in the future of cornea care."

Looking ahead, technology innovation is a key arm through which we at the Shantilal Shanghvi Cornea institute hope to both fill gaps with products that may not be mainstream but would enhance cornea care. We wish to build products that can be scaled for global impact. The future is indeed exciting, with cutting edge technologies in the fields of corneal imaging, novel therapeutics, robotics, Artificial Intelligence (AI) and biomedical engineering of the cornea.

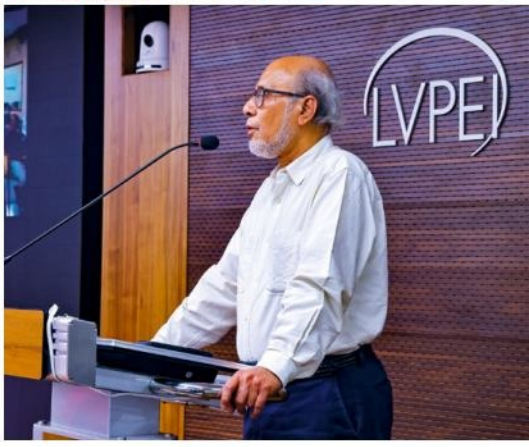
Artificial Anterior Chamber.

Photo by Ravali Modapu.

Dr Vineet Joshi
Consultant ophthalmologist, Innovation Lead of the Shantilal Shanghvi Cornea Institute

Our faculty

Photos from the SSCI inauguration event



Clinics // Eye Bank // Contact Lens // Education // Research
Rehabilitation // Innovation // Projects // Advocacy & policy
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LVPEI
So that all may see

The Shantilal Shanghvi Cornea Institute is a part of the L V Prasad Eye Institute

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