The miracle of corneal transplants

 Researchers at Krembil are striving to be world leaders in ocular regeneration

Shannon Moneo

A bout 10 years ago, Tom Tsokas had to stop driving. He was diagnosed with keratoconus in his right eye during high school, and by his late 40s, it had suddenly gotten worse. “It was like a curtain in front of my eyes,” says Tom, 56, a Stouffville, Ont., resident who works as an attendant at Toronto General Hospital. “I didn’t have a problem, but if I was reading a book I had to hold it really close to my face.” Keratoconus is a disease characterized by thinning and protrusion of the cornea, causing an irregular, conical shape and leading to blurred vision. Approximately 50 to 200 out of every 100,000 people develop keratoconus. Some possible cause is a decrease in protective antioxidants in the cornea.

Enter Dr. Allan Slomovic, clinician investigator at the Krembil Research Institute and an ophthalmologist specializing in corneal surgery at the Donald K. Johnson Eye Institute. With more than three decades of study and experience, the former clinical psychologist focused on the cornea, the clear window at the front of the eye where surgery results in the highest rates of success, he says. Since completing two prestigious fellowships at Miami’s Bascom Palmer Eye Institute, Dr. Slomovic has conducted research into conditions and procedures ranging from penetrating keratoplasty since 1986, striving to perfect the treatment along the way. In Tom’s case, after a referral by his optometrist in 2011, Dr. Slomovic and his team performed a penetrating keratoplasty. They removed a circular, full-thickness section of Tom’s damaged cornea and replaced it with healthy donor tissue that was held in place with stitches.

Following the one-hour, pain-free procedure, Tom wore a patch over his eye for 24 hours. He had the stitches removed, the only thing holding it in place is scar tissue, which is not terribly strong,” he says. People who fell and hit their eye could undo the transplant. But in 2002, Dr. Rootman became the first Canadian surgeon to perform the Partial Lamellar Keratoplasty (PLK) procedure, which eventually evolved into the Descemet’s Membrane Endothelial Keratoplasty (DMEK) procedure, a revolutionary technique in which only the diseased layers in the cornea are replaced, leaving healthy areas intact.

“I only take the inner 2 per cent – 10 to 15 microns versus 100 microns. Ten microns are the equivalent of two red blood cells stacked on top of one another,” Dr. Rootman says.

Like Dr. Slomovic, Dr. Rootman has been honing procedures that were once cutting edge. “There’s always progress. We’ve studied our results and continue to improve our techniques,” he says.

First he makes a very small incision where the cornea and the white part of the eye (sclera) meet. Looking through a 100-pound microscope that provides 20 to 40 times magnification, Dr. Rootman peels off the endothelium and Descemet’s membrane from the donor tissue, a very exacting procedure. The same thing is done to the patient’s cornea. “It’s like peeling a very thin postage stamp,” Dr. Rootman says. He then injects what he calls the “scroll” of the endothelium through a tiny glass tube, and he unfurls it inside the eye.

DMEK has proven very successful. The single, small incision either self-seals or is sutured, making the procedure safer. As well, the rejection rate is a mere 1 per cent, compared to donor rejection rates that can reach 30 per cent. DMEK is a great choice for those patients who have rejected previous transplants. “I’d rejected previous transplants [with an eye tissue]. It worked relatively well, but there was a long healing time,” the outermost layer of the cornea is the epithelium, the middle layer is the stroma and the bottom layer is the endothelium. Also a Krembil scientist, clinician investigator and an ophthalmologist specializing in corneal surgery at the Donald K. Johnson Eye Institute, Dr. Rootman says it could take many months before the transplant stabilized. During that time, and up to many years later, a 10 to 30 per cent rejection rate was possible. “And after the stitches are removed, the only thing holding it in place is scar tissue, which is not terribly strong,” he says. People who fell and hit their eye could undo the transplant.

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Later, in February 2017 at Toronto Western Hospital with Dr. Slomovic, the retired stockbroker who lives in Bracebridge, Ont., had a viral eye infection when he was six. While his right eye did all the heavy lifting, allowing him to be a hockey goalie when younger, Harold had reached the point where he could only see the “E” on the vision chart.

After surgery, like Tom, Harold wore an eye patch, and he has noticed his vision has improved. I love what I do,” says Dr. Slomovic. The retired stockbroker who lives in Bracebridge, Ont., had a viral eye infection when he was six. While his right eye did all the heavy lifting, allowing him to be a hockey goalie when younger, Harold had reached the point where he could only see the “E” on the vision chart.

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“He was recently in Israel, teaching other surgeons how to perform the technique. “I love to work with my hands and spread these techniques, and microsurgery gives me the chance,” he says.
Dr. David Rootman, left, and Dr. Allan Slomovic, right, are relentless in their pursuit of new techniques and technologies.

“I love what I do. But you have to have dedication. There are always improved techniques.”

— Dr. Allan Slomovic

says. “I get a kick out of showing people how to do surgery.”

When the front of the cornea is scarred or diseased, a different procedure called deep anterior lamellar keratoplasty may be used. “It’s definitely harder. You have to separate the internal membrane without having it rip,” says Dr. Rootman, who has performed hundreds of these transplants. “You remove the top and middle layers and preserve the inner layer.” Healthy donor tissue replaces what was removed.

Because the inner layer (endothelium) is left intact, the integrity of the cornea is maintained, healing is relatively fast, rejection is unlikely and the transplant may last a lifetime.

One area Dr. Rootman would like to further target relates to work being done in Japan, where cells from living or deceased donors are taken. The cornea cells are then mixed with an enzyme that makes them float on the surface of a petri dish, where the cells grow over a number of days. They are then injected into a patient’s eye. “I would like to start trials,” he says.

Dr. Slomovic, meanwhile, has been enhancing his artificial corneal transplant skills at Toronto Western Hospital over the last decade. He does about 15 each year, compared to the 75 non-artificial transplants he performs. “It’s sort of like a last-ditch effort. When they come to this point, there’s nothing else,” he says. For patients who have rejected donor tissues or had three or more transplants, the acrylic and titanium cornea becomes the ultimate solution.

While both researchers are approaching retirement, they are not ready to hang up their lab coats just yet. Plus, there’s much work yet to be done. “I’m having too much fun to stop now,” says Dr. Slomovic, 65.

Dr. Rootman, 61, says: “I feel like I’m the luckiest person in the world. I’m doing what I love and helping people. The work is beautiful.”

CORNEAL TRANSPLANTS

Using virtual reality to spot glaucoma

A Krembil researcher is deploying digital VR to find early signs of disease

David Israelson

To safeguard our vision, eye experts usually recommend putting aside virtual reality (VR) devices and looking away from computer screens, but Dr. Martin Steinbach has his patients doing just the opposite.

Dr. Steinbach’s vision tests started with the use of a large projector screen measuring about two square metres – the size of a TV monitor in an upscale sports bar. The viewing sensation, he says, would be similar to watching an IMAX movie.

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At the Krembil Research Institute, his research team (Dr. Esther Gonzalez, Dr. Lumi Taita-Nistor and students Taylor Brin, Saba Samet and Henry Liu) now has test participants wearing the Oculus Rift, a popular VR headset that immerses its users in their own personal movie. The Rift is not being used for entertainment here, though. The purpose is to find new ways to detect glaucoma in its early stages by measuring “vection” – the sensation viewers experience when a large part of their field of vision is moving and they feel like they too are moving, even though they are not. In patients with mild glaucoma, vision is impaired or absent.

Dr. Steinbach has been trying to find out more about peripheral vision by putting patients into these virtual reality situations and showing them a moving stimulus that makes them feel like they are also in motion. “We did this study called ‘vection in patients with glaucoma’ in 2014,” he says. “We found, by using that big field of vision, that glaucoma patients responded differently than people with