New Technology in Ophthalmology Advancing Corneal Transplants

NEW MEDICAL TECHNOLOGIES SURGERY LABORATORY TESTS OPHTHALMOLOGY TRANSPLANTOLOGY #TRANSPLANTS #LAB #CLINICAL TESTS #IMPLANTS #DRESSING

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New technologies in ophthalmology are entering transplantology. New technologies in ophthalmology are making their way into transplantology. Eye implants, artificial corneas, and advanced transplantation techniques are instilling hope in patients seeking to regain their vision. One promising approach involves artificially multiplying corneal epithelial cells, known as autologous cell culture. In Silesia, researchers are developing personalized, biodegradable dressings for treating damaged corneas using bioprinting and 3D printing. The Silesian Medical Technology Park Cardio-Med Silesia and the biotechnology start-up Acellmed are at the forefront of innovative ophthalmology projects.In Silesia, work is underway to create a personalized, biodegradable dressing for the treatment of damaged cornea using bioprinting and 3D printing.

Corneal transplants, also known as keratoplasty, are among the most frequently performed transplants. The type and method of transplantation depend on the causes and extent of the tissue pathology, which can involve the entire cornea or specific layers of the cornea.

Where are corneas for transplantation obtained?

Corneas for transplantation can be sourced from deceased donors or created artificially using keratoprosthesis. In Poland, three centers are specialized in artificial cornea transplantation: two in Silesia (Katowice and Sosnowiec) and one more recently established in Warsaw (Military Medical Institute). Currently, the national demand for keratoprostheses, designed for extreme corneal damage cases, is estimated at approximately 50 operations per year.

It is also possible to culture a part of the cornea, specifically the epithelial layer, in a laboratory setting. Innovative research in this area is being conducted in Poland, led by Dr. Dariusz Dobrowolski, an ophthalmologist and eye microsurgeon at the Department of Ophthalmology, Faculty of Medical Sciences, Zabrze, of the Silesian Medical University in Katowice. Dr. Dobrowolski has been working on corneal epithelial cell multiplication since 2006 and has collaborated on original projects in this field with Prof. Edward Wylęgała.

To grow corneal epithelium for transplantation, epithelial cells are first collected from a donor. Alternatively, the patient's own cells can be obtained from their healthy eye. This autologous, self-derived transplant significantly reduces the risk of tissue rejection and eliminates the need for lifelong immunosuppressive medications, as required with corneal transplants from other donors. A small 2 mm2 piece of corneal stroma is sufficient to initiate the culture, and properly harvested patient cells can produce a normal multilayered epithelium, including a reservoir of the patient's stem cells.

> *This method has parallels in the Italian-developed Holoclar therapy for corneal stroma cell deficiency treatment. Holoclar, approved by the European Medicines Agency in 2015, employed the patient's own stem cells. However, its availability was limited as it was exclusively prepared at a single center in Italy, resulting in logistical challenges. Hence, there was a market niche waiting to be filled.*

Alternative corneal transplantation methods from Polish experts

In Poland, experiments are ongoing to explore alternative corneal transplantation methods that utilize the patient's own stem cells and involve bio-printing and 3D printing technologies. A consortium based in Zabrze, consisting of Acellmed (ACM) and the Silesian Medical Technology Park Kardio-Med Silesia (KMS), in collaboration with experts from the Silesian Medical University in Katowice and the Wrocław University of Life Sciences, is currently working on this groundbreaking project alongside Dr. Dobrowolski.

The personalized, biodegradable dressing they are developing could treat corneal stroma cell deficiency, a condition resulting from congenital or acquired corneal issues or damage from mechanical, chemical, or thermal factors. While keratoplasty is the common treatment in such cases, it involves finding a suitable donor, long wait times, a higher risk of complications, and potential tissue rejection. The ACM and KMS solution's advantage lies in using the patient's own stem cells, eliminating the need for transplantation waiting times and lifelong immunosuppressive drugs, enabling a faster return to health and an active life. The project has successfully passed preclinical studies in a large animal model, and preparations for clinical trials are underway. The potential of this innovative dressing is significant.

> *Theoretically, it is possible to produce the entire cornea artificially, starting with printing the corneal stroma and populating it with cells, growing the epithelium, and then transplanting it onto the stroma. The challenge remains with the posterior part of the cornea, as its cells do not naturally multiply, according to Dr. Dobrowolski.*

The dressing can have applications in treating eye disorders in animals, particularly horses, dogs, or cats. If clinical trials prove successful, it may also be used in humans, especially for the increasing number of patients with eye surface burns due to ongoing armed conflicts, such as the war in Ukraine, which is expected to drive demand for this type of corneal regeneration therapy.

The advantage of the Zabrze solution over the Italian dressing includes greater surgical portability, durability, translucency, and the use of bio-printing and 3D printing technology, reflecting the latest trends in personalized medicine. This technology allows for precise placement of cultured cells, resulting in a higher-quality and more accurate solution and, consequently, increased therapeutic effectiveness. Additionally, the dressing is tailored to each specific patient, showcasing a 'tailor-made' therapy.

First Corneal Regeneration Centre in the Region

According to experts from the Zabrze consortium, if investors show interest in supporting the project, investing in further technology development, and conducting clinical trials, there is potential for establishing the first Central and Eastern European Centre for Corneal Regeneration in Silesia in the near future. Eventually, this initiative may lead to the development of a network of Corneal Regeneration Centers worldwide.

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