Regenerative corneal medicine: Ophthalmology applications

Medicina regenerativa corneal: aplicaciones en oftalmología

Dear Sir,

Regenerative medicine is a branch of this science that aims at providing strategies to restore the function of organs and/or tissues. It is a new form of therapy for patients with acute or chronic diseases in which the body is unable to restore tissue function. It is estimated that in the USA over 60 million people could benefit from this type of treatment as it covers a broad range of clinical applications in the field of medicine.1,2

Tissue regeneration mechanisms are very similar in most tissues. However, the cornea exhibits specific characteristics regarding morphology, tension, permeability and optical transparency which make it unique. It comprises a highly differentiated tissue to enable the transmission and refraction of light, which is the main optic element of the eye.3

At the level of the cornea, chemical or biological induction of regeneration by means of growth factors or other substances has brought about a significant development. Many topical agents have been utilized due to their efficient enhancement of tissue repair in wounds. Molecules such as angiotensin, retinoic acid, and amino acids such as L-arginine, soluble factors such as cytokines or interleukins, derivatives of synthetic purines, synthetic preparations of extracellular matrix and growth factors have been utilized to stimulate the operation and production of endogenous cells.

Autologous serum is also part of regenerative medicine due to its effects on the ocular surface derived from its numerous biological properties. The characteristics of serum are very similar to those of tears in what concerns pH and osmolarity and, just like tears, serum has abundant growth factors, neurotrophic factors and molecules with antibacterial action which determine that treatment will not only humidify the ocular surface but in addition will provide nutritional and growth factors which are necessary to maintain cellular feasibility as well as bactericide components that reduce the risk of contamination and infection.1–3 Tissue adhesives comprise plastic-synthetics (mostly derived from cyanoacrylates) and biological adhesives (such as those derived from fibrin). In addition, nowadays there are new adhesives derived from thrombin, hyaluronic acid, glutaraldehyde and dendritic macromeres with polyethylene glycol nucleus, making them useful for various indications. Platelet derivatives must also be considered within this group.

Another type of strategies are adult stem cell therapies obtained from the limbus or the oral mucosa in patients with limbal insufficiency in which limbal stem cells are unable to maintain the integrity of the corneal epithelium. On the other hand, we must mention artificial corneas. As it occurs with other organs, the demand for corneal transplants significantly exceeds the supply.3 The first approximation to what we could consider to be an artificial cornea is keratoprosthesis. Finally, the topical application of rho-kinase inhibitor (Y-27632) has been seen in animal models to promote endothelial cellular regeneration, as well as cellular therapy applied directly to the corneal stroma from stem cells derived from human fatty tissue. The transcendence of this new form of therapy has gone beyond the limits of scientific debate to give rise to a significant ethical debate in society and the media.1,2

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Evolution and history of contact lenses☆

Evolución histórica de las lentes de contacto

Dear Sir,

Originally, the concept of contact lenses was an idea of Leonardo da Vinci (1508) who thought about neutralizing the irregular surface of an eye by means of a regular surface full of water, thus substituting the cornea with a new refraction surface. In turn, Descartes (1836) designed a pre-corneal lens without direct support in the eye with a water interface with the same purpose. The first set of devices appeared in the late nineteenth century. Fick (Zürich, 1888) manufactured a prostheses that he called "contact Crystal" which he utilized to correct corneal irregularities, placing said crystal over the cornea and the sclera. This glass had power to correct refractive errors. In turn, Kalt (París, 1888) was the first to utilize contact lenses as "a pressure treatment for keratocones". Müller (Kiel, 1888) coined the term "corneal lenses" and was able to endure on his own eye (he was myopic, −14,00 diopters) one of these contact lenses for up to 30 min.1,2

For over 2 decades, the work of these pioneers was considered as an interesting but hardly practical idea. Glass contact lenses were difficult and expensive to manufacture and the weight and thickness made them virtually unbearable. Occasionally, the edges thereof caused ocular damage and glass broke easily. In 1936, the first contact lenses were made with translucent polymethylmethacrylate in the USA (Rhom & Haas). These plastics could be lathe cut to produce consistent and easily reproducible lenses. In addition, the lens was much thinner and therefore the intolerance gave way to the possibility of comfortable use. In 1940, T. Obring was the first to manufacture scleral contact lenses with transparent plastic. We must also credit Obring with the idea of examining the lens utilizing ultraviolet fluorescein light. In 1947, K. Tuohy was the first to manufacture contact lenses supported on the cornea instead of the sclera, having diameters of 11–12.5 mm and thickness of about 0.4 mm. G. Butterfield (1950) corrected some of the problems of the Tuohy lenses, adding peripheral curves to the internal surface in order to match the curvature of the cornea.3

All of the above achievements up to the 1950s were based on rigid and relatively waterproof materials. Before scientists understood the way in which the cornea received oxygen, they saw no need to find oxygen-permeable materials. In 1952, the history of contact lenses gave a turn with the development of hydrogel-type materials. O. Wichterle, a Czech chemist, realized that hydrogel was the perfect material for manufacturing contact lenses due to its high biocompatibility. However, the manufacturing procedure for making lenses with this material was not known until the development of the spincast centrifugal system. These new hydrogel lenses were completely different from the previous rigid ones because they contained water within a plastic matrix and therefore achieved a very important increase in comfort of use, together with allowing the passage of oxygen to the cornea. At any rate, the success of soft lenses was not immediate because they had to overcome a number of problems, including poor visual acuity and even some discomfort issues caused by their thickness despite the material they were made of.1,2

N. Gaylord developed a hybrid material, silicon acrylate polymer, which is more stable and permeable. At present, contact lenses continue to evolve and comprise a broad range of modern materials. However, one factor remains constant, which is that the contact lens must correct the refractive error

REFERENCES


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