

# Clinical Application of Ophthalmic Implant Materials and Biocompatibility

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**Abstract.** A biomedical material, which is a material to diagnose, treat and repair a living body or to replace its damaged tissue and organ, or to enhance its functions, is one of effective tools that human uses to fight against diseases.

**Keywords.** Ophthalmology, implant materials, biocompatibility.

## 1 Introduction

Eye health care and the treatment of eye diseases are always the focuses concerned in the medical field, especially after the improvement of medical level in recent years. Ophthalmic materials are indispensable parts in the treatment and health care of eye diseases. The treatment of many parts, such as the treatment of organic injury in the ocular region, needs the implantation of artificial substitutes, such as artificial eyeball and artificial tear duct. Besides, some patients with corneal diseases can restore the eyesight only by implanting an artificial cornea in their eyes; it is required to implant intraocular lens for the treatment of cataract. An ideal ophthalmic material needs to not only have stable chemical property but also have good biocompatibility so that there won't be any rejection reaction and irritation after implantation and thus patients won't feel any discomfort. Of course, materials for different purposes should have corresponding characteristics to ensure patients' comfort and safety.

## 2 Clinical application of ophthalmic implant materials

### 2.1 Intraocular lens

Intraocular lens are mostly used in the cataract surgery to replace a patient's own turbid lens removed and are the precision optical components implanted into human eyes. Based on materials, Intraocular lens can be divided into hard materials such as polymethylacrylic acid (PMMA) which is the polymethyl methacrylate that we often mentioned, soft materials including silica gel and hydrogel etc., and some acrylic vinegar Intraocular lens derived from PMMA [1-3].

The performance of Intraocular lens as an eye implant which attracts the greatest attention of people is its biocompatibility, which includes the cytotoxicity, blood compatibility and histocompatibility of materials [4,5]. The surface design of biomaterial has a good control action on the interface of a living body and transplantation material. Meanwhile, the chemical structure and surface features of chemical material also have great impacts on the biocompatibility, mainly the free energy on material surface, hydrophilic-hydrophobic balance, electric charge, chemical structure and functional group, relative molecular mass, scalability of polymer, morphological structure and surface roughness etc.

## **2.2 Artificial cornea**

At present stage, some achievements have been made in the research on tissue engineering cornea. However, there are still some shortcomings in its strength and toughness and it is transparent to a certain extent, so there is certain difference between the curative effect of tissue engineering cornea and that of living cornea. For this reason, it is the current key direction of research on tissue engineering cornea to solve such issues [6].

The ideal support materials of tissue engineering cornea have the following characteristics: (1) it has good biocompatibility; (2) with good tenacity, the tissue engineering cornea has the performance similar to that of human cornea and can form a three-dimensional structure; (3) the degradation rate of support materials can match with the degradation rate of tissue and organ formed by implanted corneal cells; after offering templates to the corneal tissue, the support can be completely degraded and absorbed, or become a integration part with new tissues; it can be molded based on defects in characteristics and technologies of corneal tissue to form a curvature, so it can well perfect the morphological repair [7]. Two types of common corneal support materials are briefly described below:

### **(1) Fibrous Protein**

The corneal epithelial cells and fibrous protein are highly compatible, so the limbal stem cells cloned on fibrous protein grow very well. The fibrous protein-based stroma supports the growth and differentiation of corneal epithelial cells. Fibrous protein can also be used in other tissues and organs, such as skin and arm muscle. Other researches show that the skin epithelial cell and arm muscle epithelial cell can grow on fibrin gel and can be transplanted successfully [8].

### **(2) Amniotic Membrane**

With good biocompatibility, the amniotic membrane, which is a semitransparent tissue, can provide basilar membrane and extracellular matrix, meanwhile, help to enhance the epithelial differentiation and strengthen epithelial connectivity. In addition, it also has the advantages such as anti-inflammation, anti-fibrosis and antiangiogenesis. Compared with the collagen lamellar, the amniotic membrane and corneal stroma lamella with the epithelium removed have better performance and are very helpful to the growth of limbal stem cells [9]. The decellularized amniotic membrane can greatly eliminate the cells and soluble constituents in tissue, can reserve the stroma and reticulate structure and has good cytocompatibility and histocompatibility, so it can serve as tissue defect material and corneal support material for tissue engineering.

## **3 Biocompatibility of ophthalmic implant materials**

### **3.1 Biocompatibility of intraocular lens**

The biocompatibility of intraocular lens can be divided into the biocompatibility of uvea and that of phacocyst. There are a lot of factors influencing biocompatibility, mainly including the material characteristics and shapes of intraocular lens. Besides, there are also some preoperative risk factors, such as glaucoma, diabetes mellitus and uveitis. Scientific and proper selection of intraocular lens can effectively enhance the postoperative clinical effect. It is true that the application of intraocular **lens** also has some complications, mainly including the following types: (1) inflammatory reactions, such as intractable uveitis, infectious endophthalmitis and toxic symptom complex of intraocular lens etc. (2) turbid refractive mesenchyme (3) Intraocular lens-induced mechanical complications (4) complications induced in intraocular lens (4) corneal complications such as corneal decompensation, edema and diastasis etc. (5) corneal complications etc. (6) Iritis complications such as iris abrasion and corrosion, iris prolapsed and peripheral anterior synechia of iris etc. [10,11].

### **3.2 Biocompatibility of artificial lens**

Among several types of biomaterials of artificial cornea, the biocompatibility of collagen and chitosan are slightly poorer. The integration between materials and host is poor; the degradation rate fails to match with the generation rate of new tissues; the materials have no surface specificity. However, fibrous protein, amniotic membrane, PGA and polylactide

PGA can serve as tissue defect materials and corneal support materials for tissue engineering and have good biocompatibility [12-14].

In these years, the optic materials in the center of artificial cornea include silica gel and polymethylmethacrylate, both of which have the common characteristics such as long-term stability, high toughness, clearness, transparency and low toxicity. However, their obvious shortcoming is that they don't support the growth of epithelial cells, go against the diffusion of nutrient substances and cannot be degraded. Hydrogel can swell in water, is elastic, transparent, highly flexible and highly elastic, can help the diffusion of nutrient substances and is very helpful to the growth of epithelial cells after treatment [15]. The artificial cornea has good and stable optical performance but its biocompatibility is poorer than that of tissue engineering cornea. New composite materials, such as collagen and hydrogel, formed by organically combining the two types of materials will probably become the new composite biological support materials.

## 4 Conclusion

Ophthalmic implant materials have been widely used in the treatment of all sorts of ophthalmic diseases; artificial implants made from different biomaterials are more and more popular in the treatment of ophthalmic diseases. Thus, properly selecting an implant with good biocompatibility can attain a satisfactory clinical effect.

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