COATED INTRAOCULAR LENS AND SURGICAL TOOL

BACKGROUND

When the natural lens of the human eye becomes physically damaged or has some disease necessitating its removal, such as a cataract, it is often replaced with an artificial intraocular lens.

During the process of surgically implanting such lens through an incision at the edge of the cornea, it has been found that static touching of the corneal endothelium with a polymethylmethacrylate (PMMA) or other surgical tool, can permanently destroy a portion of the endothelial cells. It is generally recognized that the human endothelium, which is only one cell layer thick, cannot regenerate itself by producing additional cells. It appears that more damage is done to the corneal endothelium by a dynamic or sliding contact with such lens or tool during surgery as compared to a static or nonsliding contact with the endothelium. The corneal endothelium is very critical to the eye as it is a barrier between the outer layers of the cornea and the aqueous humor in the anterior chamber. After surgery, the location of the intraocular lens is such that, when in its proper position, it does not contact or damage the corneal endothelium.

It has been suggested by others to coat the intraocular lens with methylcellulose (MC) or polyvinylpyrrolidone (PVP). The following publications describe such coating.

- Kaufman, H. E. and J. I. Katz, "Endothelial Damage From Intraocular Lens Insertion," *Inv. Ophth.*, Vol. 15(12), December 1976, p. 996–1000
- Kaufman, H. E., Jeffrey Katz, et al, "Prevention of Endothelial Damage From Intraocular Lens Insertion," *Tr. Am. Acad. Ophth. & Otol.*, Vol. 83, March-April 1977, p. 204–212
- Kaufman, H. E. and J. I. Katz, "Pathology of the Corneal Endothelium," *Inv. Ophth. Visual Sci.*, Vol. 16(4), April 1977, p. 265–268
- Fechner, P. U., "Methylcellulose in Lens Implantation," *Jour. Amer. Intraocular Implant Society*, Vol. 3(3 & 4), July-October 1977, p. 180–181
- Kaufman, H. E., Jeffrey Katz, et al, "Corneal Endothelium Damage with Intraocular Lenses: Contact Adhesion Between Surgical Materials and Tissue," *Science*, Vol. 198(4316), November, 4, 1977, p. 525–527.

While the above coatings of MC and PVP helped protect the corneal endothelium during surgery, they had several shortcomings. A supply of methylcellulose used by Dr. Kaufman in the above publications was obtained from him and tested. It was found to be a very poor film former and tended to "bead up" on the PMMA lens exposing edges of the lens. It has been found that MC has a very fast dissolution rate. Dipping of lenses in MC or PVP is useful to protect the corneal endothelium. However, because of the fast dissolution rate of these polymers and the difficulty of placing a controlled amount of such polymers on the lenses, the extent and length of time of protection is uncontrollable. Because of the wet and slippery nature of lenses dipped during surgery, the lenses are difficult to handle and a portion of the coating may drip off. In addition, MC and PVP solutions must be sterilized prior to dipping. The amount and type of contact with the corneal endothelium varies with the skills and techniques of different ophthalmic surgeons. It is highly desirable to have a coating that protects against both static and dynamic sliding contact.

SUMMARY OF THE INVENTION

The present invention overcomes the above problems by providing an adherent film coating that dissolves very slowly in water. This coating is on an intraocular lens or ophthalmic surgery tool and is supplied in a dehydrated state to the ophthalmologist who rehydrates the coating immediately prior to surgery. This coating, such as polyvinyl alcohol, clings to the lens or the like and maintains at least 40% of the coating on the lens for at least 30 minutes when submerged in a water bath simulating the wet surgical site. The coating is biocompatible and dissolvable in approximately 24 hours or less after surgery so as not to remain on the lens.

The present application deals with the coated intraocular lens and surgical tools themselves. A related copending application by the same inventors entitled "Method of Treating Intraocular Lens Or The Like," filed Nov. 30, 1977, Ser. No. 855,962, deals with the method of coating, dehydrating, and rehydrating a lens or surgical tool.

THE DRAWINGS

FIG. **1** is a rear prospective view of an intraocular lens coated according to this invention;

FIG. **2** is an enlarged sectional view taken along line **2**—**2** of FIG. **1** showing the coating in a dehydrated state;

FIG. **3** is an enlarged sectional view similar to that of FIG. **2**, but showing the coating in a hydrated state;

FIG. **4** is a sectional view schematically showing the intraocular lens implanted within an eye; and

FIG. **5** is a fragmentary prospective view of coated tip sections of an ophthalmic surgery forceps.

DETAILED DESCRIPTION

FIG. **1** shows the rear of a typical intraocular lens with an optic section indicated generally as **1**. To this optic section are secured a pair of iris engaging retention loops **2** and **3** that include shank sections, such as **4**, **5**, **6**, and **7** securing the loops to the optic portion of the lens.

A lens coating shown as **8** covers the entire front surface of the optical portion **1** of the lens. It is the front surface of this lens that is most likely to contact the corneal endothelium during surgery. The coating covers a peripheral edge of the lens, as at **9**, and can also include a circumferential band **10** on a back surface of the optical section **1**, if desired. Thus, all portions of the intraocular lens that are likely to contact the corneal endothelium are adequately protected. The iris retention loops are not coated, because the coating bridges the loops and accumulates excessive material on the loops. It is desirable to keep the coating material to a minimum amount so it does not biologically interfere with the function of the eye and can readily be absorbed by the body. It is believed that such coating of this invention is removed from the eye through the continuous biological flushing of the anterior chamber. The dissolved material is eventually excreted through the urine or metabolized.

FIG. **2** shows the coating after it has been applied and dehydrated to remove substantially all of the water in