

## INTRAOCULAR LENS IMPLANTS

The present invention relates to intraocular lens. It is known to replace the natural crystalline lens following cataract extraction. Many people on whom cataract operations are performed receive an intraocular lens implant. However, there is a need for a safer and more effective intraocular lens than those which have been available hitherto. The most commonly used material for intraocular lens has been polymethylmethacrylate (PMMA). PMMA has a number of characteristics making it suitable for use as an intraocular lens implant. However, it has been shown to be particularly injurious to the corneal endothelium. The corneal endothelium is a thin layer at the back of the cornea. The maintenance of corneal clarity is dependent on the endothelium which is essentially non-regenerative. There appears to be a bio-physical interaction between the hydrophobic PMMA and the endothelium such that even momentary touch on insertion will cause significant endothelial cell disruption by adherence of the cells to the lens surface.

Loss of endothelial cells at the time of surgery can lead to loss of corneal transparency several years later. There are other problems attendant with the use of PMMA as an implant material.

In accordance with the present invention there is provided a self-supporting intraocular lens formed of a hydrogel.

A hydrogel is an organic polymeric or copolymeric material comprising hydrophilic monomers. The hydrogel material swells upon being hydrated and becomes soft and flexible. One particularly useful hydrogel is hydroxyethyl methacrylate (HEMA) and it has been found that this material causes little endothelial damage on contact. Also, since hydrogels are hydrophilic in nature endothelial damage is generally less than with PMMA.

Other types of hydrogel which may be used in the present invention are copolymers of vinyl pyrrolidone with HEMA or methyl methacrylate, copolymers of glyceryl methacrylate and methyl methacrylate and copolymers of HEMA and diacetone acrylamide.

The hydrogel intraocular lens of the present invention could be useful in the anterior chamber of the eye or the posterior chamber, but it is particularly envisaged for use in the posterior chamber.

It has been found in particular that a HEMA hydrogel lens manufactured from HEMA having the capability of absorbing about 38% of its weight of water, makes a particularly useful posterior chamber intraocular lens.

Preferably, the intraocular lens implant is of integral construction and comprises a relatively thick optical portion having relatively thin resilient flange means extending away from it, said flange means being arranged to retain the implant in place in the eye.

The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a plan view of a self-supporting intraocular lens in accordance with one embodiment of the present invention;

FIG. 2 is a side elevation of the intraocular lens implant of FIG. 1;

FIG. 3 is a plan view of an intraocular lens implant in accordance with another embodiment of the present invention;

FIG. 4a is a cross-sectional view of an eye with an implant according to FIGS. 1 and 2 in place with a ciliary sulcus placement;

FIG. 4b is a cross-sectional view of an eye with an implant according to FIGS. 1 and 2 in place with a capsule bag placement;

FIGS. 5 to 8, 10 and 11 are views similar to that of FIG. 4a showing alternative intraocular lens configurations in accordance with the present invention;

FIGS. 9 and 12 are plan views of the lens shown in FIGS. 8 and 11 respectively; and

FIG. 13 is a side elevation of a package containing an intraocular lens implant in accordance with the present invention.

In FIGS. 1 and 2, there is shown a self-supporting intraocular lens 10 comprising a central optical portion 12 which is in the form of a lens. As shown, the lens construction does not rely on the iris for support. The central optical portion 12 is flanked by laterally extending flanges 14. The implant has a posterior face 16 and an anterior face 18. The lens implant of FIGS. 1 and 2 is arranged to be inserted in the posterior chamber of an eye.

As can be seen in FIG. 2, the optical portion 12 is of asymmetrical biconvex construction which gives good optical resolution. The posterior face 16 is at a standard curvature such as a curve having a radius of about 17 mm. The posterior face 16 is, in this case, a non-variable optical surface whilst the anterior face 18 is an optical surface of varying power. In other lens constructions, the anterior face 18 may be a non-variable optical surface whilst the posterior face 16 may be an optical surface of varying power. Thus, in the embodiment illustrated in FIG. 2, the optical properties of the optical portion 12 can be varied by varying the curvature of the anterior face of the optical portion 12. The ratio of curvature is preferably approximately 3:1 which computer analysis shows to provide optimum ocular resolution for an intraocular lens. The power of each eye is different and therefore the thickness of the optical portion 12 and the curvature of the anterior face 18 thereof will vary from case to case. The technique for forming the correct shape of the anterior face and thickness of the optical portion 12 are known. The lens implant shown in FIG. 3 is similar to that shown in FIGS. 1 and 2, except that the flanges 14 have been replaced by a single circular flange 15 which completely surrounds the optical portion 12. The flange 15 is of similar cross-sectional shape and thickness to the flanges 14. The curvature of the posterior face 16 is preferably such that the resultant lens will be of asymmetrical biconvex construction with the posterior face having the larger curvature as shown in FIG. 2.

Further, the optical portion 12 and flanges 14 are formed in an integral unit, that is the entire implant 10 is formed in one piece. The flanges 14 may be of a wide variety of thickness but are preferably between 0.02 and 0.2 mm thick. More preferably, the flanges 14 are between 0.10 and 0.18 mm thick such as about 0.14 mm thick. The optical portion 12 is thicker than the flanges 14 but, as described above, its actual thickness will vary with optical requirements of the lens implant 10. A typical thickness for the optical portion 12 is about 0.9 mm.

The implant 10 is formed of a hydrogel material such as HEMA and the flanges 14 are therefore resilient. However, the optical portion 12 is thick enough to be sufficiently rigid to provide stable optical correction.