ANTERIOR CHAMBER LENS

FIELD OF THE INVENTION

The present invention relates to an anterior chamber intraocular lens and, more particularly, a universal anterior chamber lens which may fit many sized eyes within the range of the usual variation in eye sizes.

BACKGROUND OF THE INVENTION

It is now commonly accepted that the vision impairing disease known as cataracts can be alleviated by surgically replacing the natural lens of the eye with an artificial intraocular lens.

The anatomy of the eye **1** is shown schematically in FIG. **1A**. The cornea **2** forms the front surface of the eye and connects with the ciliary muscle **3**, from which the iris **4** extends. Iris **4** divides the front portion of the eye into the anterior chamber **5**, between the iris **4** and cornea **2**, and a posterior chamber **6** behind iris **4**. A circumferential groove in the vicinity of ciliary muscle **3**, anterior of iris **4** is the anterior chamber angle **8**. Pupil **9** is the aperture at the center of iris **4** through which light passes to posterior chamber **6** and the back of the eye. The natural lens of the eye (not shown) is supported in posterior chamber **6** by suspensory ligaments (also not shown). The remainder of the eye **7** is called the vitreous chamber through which light passes to reach the retina, from which the image is sensed by the optic nerve.

A variety of lens assemblies are available for implantation in the eye. Specific lenses have been designed for placement in anterior chamber **5** of the eye. Other lenses have been specifically designed for placement in posterior chamber **6** and other lenses have been designed for attachment directly to the iris **4**.

The dimensions of the human eye vary significantly from person to person. Thus, intraocular lens manufacturers must provide lenses in a variety of sizes to fit different people. It would be desirable to have a single, universal lens which would fit a variety of eye sizes.

Intraocular lenses have two principal parts: a medial, light-focusing body (also called the optic) made of a nontoxic, plastic material which will replace the natural lens of the eye and focus light on the retina, and haptic support portions which extend from the optic to the anatomy of the eye and provide a means for fixing and holding the optic in its proper position within the eye. The haptic portions must control the position of the optic along orthogonal axes X, Y and Z,; shown in FIGS. **1A** and **1B**. Proper centration with respect to the X and Y axes is important to keep the optic properly aligned with pupil **9**. If the center of the optic gets too far away from the intersection of the X and Y axes, the optic is said to be decentered, so only a portion of the light impinging on the optic will be properly focused through the pupil onto the retina.

It is also important to control the motion of the optic along the Z axis. Particularly with an anterior chamber lens, it is important to prevent the optic from touching the anterior surface of iris **4**, and it is important to prevent the optic from touching the posterior surface of cornea **2**. Thus, the haptics must support the optic a preferred distance away from iris **4** and cornea **2**. It is also important to prevent the lens from tilting, that is rotating to any substantial degree, about either the X or Y axes. Such tilting prevents the light from being properly focused by the optic on the retina.

Especially for an anterior chamber lens, it is also important that the lens can accommodate the natural deformation which the eye experiences in routine daily activity caused, for example, by rubbing the eye, running or falling.

A relatively early version of an anterior chamber lens is shown in U.S. Pat. No. 2,834,023, which includes an optic and a wire or plastic haptic glued into an open groove on the edge of the optic. The ends of the haptic are mounted in the angle of the eye. The haptic is a rod-like configuration formed into flexible loops or wings to support the optic against undesirable movement in the anterior chamber while at the same time permitting flexing to accommodate the stresses induced by normal movement of the eye. In more recent designs, as shown, for example, in U.S. Pat. Nos. 4,087,866 and 4,261,065, anterior chamber lenses have been made as a single piece, with the optic and the supporting haptic structure formed of the same material. These solid unitary haptics provide very good control for the optic against decentering tilting or vaulting. However, they are less flexible and, thus, must be very carefully fitted to the eye.

One attempt to properly fit an anterior chamber intraocular lens is shown in U.S. Pat. No. 4,134,160 where one of the haptic feet is formed in two pieces with an adjustable tab which can be slid out to the proper radius to fit the eye and then crimped into position.

U.S. Pat. No. 4,370,760 is an attempt to make a universal anterior chamber lens which has a greater degree of flexibility than the previously described anterior chamber lenses but which is stated to achieve control over motion of the optic along the Z axis between the iris and the cornea. This is also a one-piece lens where the optic and the haptic portions are made of the same unitary material.

One-piece lenses can be difficult and expensive to manufacture. The lens shown in U.S. Pat. No. 4,159,546, popularly known as the Shearing or J-loop lens, has what is called open-loop haptic supports made of flexible, memory retaining, polypropylene filament, which act like springs. This lens is easy and relatively inexpensive to manufacture. This lens has had great popular acceptance and achieves excellent results. However, it is used principally in the posterior chamber of the eye.

It would be very desirable to have a single universal anterior chamber lens to fit a variety of eye sizes which had the great flexibility of open-loop lenses but which, at the same time, provided a high degree of control over the motion of the optic provided by the one-piece anterior chamber lenses.

SUMMARY OF THE INVENTION

The present invention is a universal, anterior-chamber lens which provides very good flexibility of the haptic supports and at the same time provides good control over the motion of the optic in the anterior chamber to control centration, tilt and vault. The anterior chamber intraocular lens of the present invention includes an optic having an anterior and a posterior surface and a surrounding circumferential edge. The optic has at least one bore entering the optic at the edge and extending into the optic. In an alternative construction, the bore can extend straight through the optic and exit at another portion of the edge of the optic. The lens