INTRAOCULAR LENS ASSEMBLIES

BACKGROUND OF THE INVENTION

This invention relates to intraocular lens assemblies for implantation into the posterior chamber of a human eye and, more particularly, to accommodating lens assemblies for implantation during cataract eye surgery.

Heretofore, conventional cataract surgery has involved the removal of the normal lens of a human eye and replacement thereof with an artificial intraocular lens assembly which does not have the the ability to change shape for focusing at different distances, as can the normal lens of the eye. The normal lens has the capability of focusing objects in a range of distances which varies from a near point of about 50 millimeters to a far point of infinity. This focusing effect is accomplished by a process known as accommodation. However, the heretofore standard replacement lenses have been fixed focus lenses designed for either distant or close-up vision and have lacked the ability to achieve accommodation. Thus, a patient, having one of these prior lenses implanted during surgery, typically has been required to wear appropriate conventional bifocal or reading glasses thereafter to compensate for the non-accommodating nature of the implant.

U.S. Pat. No. 4,254,509 discloses an intraocular lens structure which is taught to provide properties of accommodation. The lens structure therein includes an optical lens portion which is incapable of changing its curvature since it is formed from a rigid methyl methacrylate-type material such as polymethyl methacrylate ("PMMA"). This rigid, fixed configuration lens portion is supported by haptics which are integrally formed with coplanar oppositely directed feet. The haptics are constructed from a soft, relatively flexible material such as soft hydrogels of hydrophylic type including 2-hydroxyethyl methacrylate ("PHEMA"). These supporting haptics have an archlike configuration, convex side facing the cornea, so that the optic will not touch the iris but will be slightly anterior to it when the structure is implanted in the anterior chamber of the eye. Focusing power of this prior assembly is said to change through anterior movement of the optic resulting from central compressive force exerted on the feet and translated through the soft haptics to the lens upon contraction of the ciliary muscle when the lens is implanted in the anterior chamber of the eye. That is, the patent teaches that central compression of the soft haptics of the lens implanted in the anterior chamber of the eye displaces the lens forward and, thereby, increases the optical power of the system by moving the focusing lens away from the retina. However, it has been found that this system when implanted as taught in the patent does not solve the problem of providing an operationally effective accommodating lens assembly.

A disadvantage of the prior lens assembly is that it is configured for implantation into the anterior chamber of the eye wherein the feet of the haptic supporting the lens are in the anterior chamber angle and, therefore, are effectively in contact with the scleral spur or iris root. As described, the feet of the lens thus positioned in the anterior chamber are pushed centrally during accommodation by an amount sufficient to result in a useful increase in accommodative power. However, it has been found that contraction of the ciliary muscle does not move the scleral spur or iris root centrally or anteriorly. Accordingly, insufficient central movement occurs at the periphery of the anterior chamber to achieve the necessary accommodation with these lens assemblies. Furthermore, to the extend that there is any central displacement of these lens assemblies, less than a millimeter of anterior movement can be achieved in the anterior chamber of the eye when clearance of the iris and cornea are considered. This amount of movement would provide less than about 1 diopter of accommodation utilizing these lens assemblies whereas at least about 3 diopters of accommodation are required to allow focus to go from distance to normal reading vision and about 5 diopters to achieve this degree of accommodation without asthenopia (discomfort resulting from eye strain). Indeed, at least about 8 diopters is preferred to develop an operationally effective accommodating lens system in view of the difficulty in predicting a lens power which would result in ideal distance vision.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide intraocular lens assemblies which avoid the disadvantages inherent in the prior lens assemblies. Specifically, it is a primary object of this invention to provide accommodating lens assemblies for implantation into the posterior chamber of the human eye. Another primary object is to provide accommodating lens assemblies wherein at least about a 3 diopter change in the focusing power of the eye is achieved and, preferably, the degree of accommodation achieved is at least about 5 diopters, most preferably at least about 8 diopters.

In accordance with the present invention, intraocular lens assemblies are provided which utilize the ciliary muscle to produce changes in lens curvature and geometry whereby accommodation is achieved. Specifically, the assemblies of this invention include ring structures which support deformable central lens structures. The ring structures comprise outer ring members having web members extending therefrom. These web members are connected at there distal ends to the central lens structures or are formed integral with and as a unitary extension of the central lens. The lens structures are constructed from elastic materials which have the ability to be extended or compressed when appropriate radial pressure is applied thereto and to essentially return to their original shapes when such pressure is relaxed. These lens structures act as the deformable focusing or optic portions of the assemblies.

The outer ring members of the ring structures are adapted to engage with and to be compressed by contraction of the ciliary muscle after implantation of the assembly into the eye whereby tension on the optic is relaxed to enable adjustment of the curvature and geometry of the central lens to achieve accommodation. More specifically, as radial tension transmitted from the ring to the central lens is relaxed, the lens contracts its diameter from its original minimum focusing or non-accommodative shape causing an increase in the central thickness of the lens thereby increasing curvature of the lens and the focusing power thereof. Subsequently, as outer ring tension is increased on the lens via muscle relaxation, the lens will expand its diameter as a function of the tension exerted thereon so that the shape of the lens will revert to the original non-accommodative form as the tension applied thereto returns to the initial level.