LASER ADJUSTABLE INTRAOCULAR LENS AND METHOD OF ALTERING LENS POWER

BACKGROUND OF THE INVENTION

This invention relates to an intraocular lens. In particular, this invention relates to an intraocular lens that can have its prescriptive or refractive power altered while positioned in the eye.

The eye is a complex organ that permits a person to see. In its simplest form, the eye consists of a transparent outer portion called the cornea, a transparent crystalline lens positioned behind the cornea, and the retina, positioned behind the lens. In a normal eye, a person sees when an image passes through the cornea, and that image is in turn focused by the lens onto the retina. The retina then transfers the "image" to the brain.

The crystalline lens in a normal eye is optically transparent. It adjusts its thickness, e.g. focuses, in response to the distance between the eye and the object being viewed. Essential to good vision is the optical transparency or crystallinity of the lens. Advancing age and various diseases can alter the crystalline properites of the lens by the formation of dark spots or opacities known medically as cataracts in the lens. The effect of a cataract on good vision is the same as a dirty window. The cataract interferes with light passing through the lens and impinging on the retina.

The current treatment for cataracts is to surgically remove the lens so that light can once again reach the retina. This is equivalent to removing or washing the previous dirty window. When the lens is removed however, the person loses that part of the eye—the lens—that serves to focus and form sharp images on the retina. Images still form on the retina but they are diffuse, ill-defined and otherwise out of focus.

As a result, when a lens is removed to eliminate cataracts, it must be replaced by an artificial lens. This can be done by providing spectacles to be worn on the face of the patient. Spectacles for patients having the natural eye lens removed (also known as aphakic patients) are quite thick, heavy and unattractive. Contact lenses are an alternative to spectacles since the aphakic patient will not be required to wear heavy, bulky, unattractive spectacles. A disadvantage of contact lenses however is that the typical aphakic patient is a senior citizen who finds it difficult to handle the small contact lens when it is being transferred from its storage container and is being placed in or removed from the eye. As a result senior citizens often lose, damage, or misplace the contact lens.

The most preferred method for restoring vision in an aphakic patient is to surgically implant a lens within the eye. Such a lens, known to ophthalmologists as an intraocular lens, need not and cannot be removed on a regular basis and since it is positioned in approximately the same position as the natural lens, provides vision correction without undue magnification of the image.

A problem associated with the proper implantation of an intraocular lens is the accurate determination of the exact prescriptive or refractive power of the lens to be placed in the patient's eye. The ophthalmologist can, for example, attempt to measure the prescriptive power of the patient's natural lens and, through the use of various measuring devices, e.g. ultrasound, measure the depth and diameter of the eye. These measurements in conjunction with clinical experience permit the opthalmologist to relatively accurately determine the proper refraction or power of the intraocular lens to be placed in the patient's eye. In the vast majority of the cases, the aphakic patient can have an intraocular lens implanted which provides good distance visual acuity even though spectacles will be required for reading since the intraocular lens cannot change its refraction or power like a natural lens.

In some cases however, despite the best efforts of the opthalmologist, the lens surgically placed in the patent's eye does not provide good distance visual acuity. In particular, presently available intraocular lens do not correct astigmatic refractive errors. Since most of the astigmatism present after cataract surgery is due to the surgical incision and changes in corneal curvature attendant to the incision's healing, the exact amount and axis of astigmatism cannot be accurately determined until some time, usually several weeks, after the surgery. Since the old intraocular lens cannot be readily removed and a new intraocular lens with a different power surgically installed without unduly jeopardizing the aphakic patient's vision, the patient must rely on spectacles to provide good distance visual acuity. In other words, although the need to wear heavy, bulky, unsightly spectacles is eliminated, the patient will nevertheless be required to wear spectacles on a full time basis for good distance vision or to cure postoperative astigmatism.

The prior art has recognized this problem. For example, Schachar U.S. Pat. No. 4,373,218 describes an intraocular lens having the form of a fluid expansible, optically transparent sac which can be expanded or contracted by fluid pressure to vary the power of the intraocular lens.

The prior art has also used lasers in conjunction with the correction of vision defects. For example, lasers have been used to repair retinal detachments and to reduce edema in the macula. In addition, as described in U.S. Pat. No. 4,461,294, light absorbing bodies are deposited in preselected portions of the cornea. These light absorbing bodies are then contacted with a laser to generate scar tissue which alter the shape of the cornea thereby correcting refractive errors of the eye.

Lasers have also been used in conjunction with intraocular and contact lenses. For example, lasers have been used to mark plastic lenses as described in U.S. Pat. No. 4,219,721 or to actually machine and polish an optical surface during manufacture of a lens as described in U.S. Pat. No. 4,307,046.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a method of altering the corrective power of an implanted intraocular lens.

It is a specific object of this invention to provide a method of altering the corrective power of an implanted intraocular lens utilizing laser energy.

It is another object of this invention to provide an intraocular lens which can be implanted in an eye and which can have its corrective power effectively and safely altered by contact with laser energy.

In accordance with the present invention, these objects are accomplished by contacting a selected portion of an intraocular lens, while it is implanted in the eye with a laser beam. The intensity of the laser beam and time of contact are selected to provide conditions sufficient to alter the shape of the intraocular lens thereby altering its corrective power without substantially and