

FIG. 5 is a sectional view taken along line 5—5 of FIG. 4;

FIG. 6 is yet another sectional detail, in perspective, illustrating an alternative implant sequence in accordance with the present invention;

FIG. 7 is a further sectional detail in the sequence shown in FIG. 6; and

FIG. 8 is a sectional view taken along line 8—8 of FIG. 7.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in FIG. 1 the anatomical structure of a human eye E is characterized by a cornea C on the frontal segment of the limbus L extending over the variable aperture in the iris I. Below the iris I, suspended on ligaments (zonules) S is a capsular structure CS defined by an anterior capsule AC and a posterior capsule PC between which the clear lens substance LS is contained. Muscular contraction at the ligaments (zonules) S then, by tensile extension, modifies the shape of the lens capsules and thus modifies the optical path of the lens.

A variety of pathological processes are known which in one way or another affect the lens. Most prominent amongst these processes is cataract. The pathology of cataract involves the lens substance LS with a consequent reduction of optical functions through the lens.

Typically the effect of this disease is corrected by the removal of the lens including one or both capsular membranes. The function of the lens is then replaced either by a synthetic lens implant or by extremely thick and heavy glasses which must thereafter be consistently worn.

Heretofore techniques were devised for ultrasonic or mechanical withdrawal of the diseased lens substance from within the capsular bag. Typically, such withdrawal is by way of narrow instruments e.g., a syringe, illustrated in FIG. 2 by a syringe needle N. To evacuate the lens substance LS a narrow opening 11 is made in the cornea or limbus of the eye and through this opening the needle N is extended to pass through the anterior capsule AC. The lens substance LS is then evacuated from between the capsules.

In accordance with the present invention, following the evacuation of the lens substance LS, a second, somewhat larger, syringe needle 21, illustrated in FIG. 3, is inserted through opening 11. Of course, other tools, like a forcep, may be useful for the purpose herein. Needle 21 includes a central bore 22 in which a collapsed lens sack, generally at 50, is stored in a longitudinal, rolled column. A syringe 23, attached to needle 22, is then useful to expel the sack

As shown in FIGS. 4 and 5 sack 50 may comprise two concentric cavities 55 and 65, cavity 55 formed as a toroidal, peripheral, tube around the central cavity 65. This concentric structure may be formed from a variety of resilient, biologically acceptable materials and may be provided with a resilient manifold, or tubular projections, 56 and 66 extending to communicate with cavities 55 and 65. When collapsed and folded for storage within needle 21 these tubular projections 56 and 66 are aligned rearmost, towards the syringe, within bore 22 and when the sack is expelled into the evacuated capsular bag formed by capsules AC and PC the projections 65 emerge towards the incision 11. In this position both cavities 55 and 65 may be selectively expanded by further injection of clear fluid from a fine tipped syringe 57

to the shape defined by the fluid pressure and the elastic coefficient of the sack walls.

By particular reference to FIGS. 4 and 5 the inserted sack 50, formed of an elastomer like clear polyethylene or silicon, includes the aforementioned peripheral cavity 55 extending about the central lens sack 65. Cavity 55 operates as a capsular spreader and thus its toroidal wall 58 is formed at a thickness sufficient for partial expansion by the elastic stiffness alone. Thus once expelled from the insertion needle 21 into the evacuated capsular bag the toroidal cavity 55 begins to uncurl and with the manipulative assistance by the attending physician, is positioned in the capsular bag for peripheral alignment. The lens sack 65, in turn, may comprise various wall thicknesses shown at 68a and b which, at pressure effect the desired lens shape. Accordingly, the tubular projections 56 and 66 are useful both to effect the positioning of the unexpanded sack 50 and thereafter for the injection of the internal fluid 60 once so positioned. For this purpose the projections may be provided with self-sealing orifices 56a and 66a or may be clamped off and sealed in place.

In the alternative, as shown in FIGS. 6-8, a plurality of arcuate, resilient spreader segments 155 and 156 may be inserted by expulsion from a syringe needle 121 into the evacuated capsular bag. To provide manipulative convenience needle 121 may be arced in the direction of the arc prestress of each segment 155 and 156. Once in position around the capsular periphery the spreaders then present a central cavity into which a lens sack 165, provided with a tubular projection 166, is received. This lens capsule, once again, may be stored in a syringe needle 123 to be expelled therefrom by syringe pressure, and when expelled is thereafter pressurized in the manner described above.

In both examples the peripheral juncture of the anterior and posterior capsules AC and DC is separated to limit the post operative regrowth of lens substance. This mechanical spreading of the capsular membranes for receipt of the lens sack is particularly useful since the natural capsular membranes are extremely thin and delicate and thus easily torn. The incidence of capsular tearing is thus reduced particularly with well rounded edges on the resilient inserts described herein.

Obviously, many modifications and changes may be made to the foregoing without departing from the spirit of the invention. It is therefore intended that the scope of the invention be determined solely on the claims appended hereto.

What is claimed is:

1. A method for implanting synthetic lenses into the natural capsular bag of a human eye, comprising the steps of:

- making an incision in the said eye communicating into the interior of said capsular bag;
- evacuating the natural lens substance from said capsular bag through said incision;
- inserting a collapsed, expandable lens insert into a hollow needle, said lens insert including an exterior toroidal cavity formed at the periphery of a substantially circular lens cavity;
- expelling said lens insert from said hollow needle through said incision into said evacuated capsular bag;
- pressuring by injecting liquid under pressure into said toroidal cavity; and
- expanding by liquid pressure said lens cavity.

2. A method in accordance with claim 1 wherein: