LMI-A New Mirror Telescopic IOL
(A New Solution For The Optical Rehabilitation Of Patients With Age Related Macular Degeneration And Other Macular Pathologies)

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Introduction

Macular pathologies cause a great amount of morbidity and mortality world wide and have significant impact on community health. Age related macular degeneration (ARMD) is the leading cause of legal blindness in the industrial world. ARMD has been divided into dry or exudative and wet or nonexudative types. Recently the AMD prosthetic device, Implantable Miniature Telescope (IMT- by Dr. Isaac Lipshitz), was tested. The drawbacks encountered in the IMT included loss of peripheral vision in the implanted eye, difficult surgical technique, endothelial compromise (Fig 1), blocked peripheral retinal visibility, difficulty in future retinal laser treatments, difficulty due to the size & weight of the implant, severe aniseikonia due to disparity of images of two eyes etc.

To solve these problems, we designed a new IOL, which magnifies the image on the retina based on a mirror telescope: the LMI-Lipshitz Macular implant. The implant was designed by one of us (Dr. Isaac Lipshitz). We aimed to test this IOL not only on patients with dry or wet ARMD but also other diseases which affect the macula thus affecting central vision. This was the first experimental trial of this novel surgical implant.

LMI-Mirror Telescopic IOL

The LMI (Fig 2) is a regular IOL that incorporates two miniature mirrors in Cassagrain telescopic configuration. These mirrors act by modifying the image on the retina (Fig 3) The IOL has a dual optical system which ensures that light passing through the center of the optic is magnified by the Cassagrain telescope whereas the light passing through the periphery passes through the normal IOL configuration. Overall diameter
The anterior, central mirror size is 1.4 mm. The posterior mirror is doughnut shaped and 2.8 mm in diameter with a central clear area of 1.4 mm diameter. The peripheral zone of the optic is similar to a normal IOL for undisturbed peripheral vision. The reflecting surfaces of the LMI are coated with multiple layers of TiO2 & SiO2 (dielectric coatings) thus creating the mirror effect. The thickness of these mirrors is only 1-2μ. The entire IOL is also coated with Parylene C (poly-para-xlylenes) for the reasons of biocompatibility.

This LMI was designed to have x 2.5 magnification i.e. it magnifies the central image on the retina 2.5 times (Fig 4). The subject thus sees a magnified central image through the mirror telescope and a normal non-magnified image through the periphery of the IOL, thus increasing the magnified central vision while maintaining the orientation in space due to normal peripheral vision. Testing was done on the lab while preparing the IOL (Fig 5).

**Patient Selection Criteria**

Patients with bilateral macular pathologies with visual acuity less than 20/200, cataract less than NS grade II and having no other ocular or systemic diseases and in whom the vision improved when tested with x 2.5 external telescope preoperatively were selected. Informed consent was taken from all patients after explaining to them the potential benefits and possible complications of the procedure. Patients’ motivation, communication skills and availability for follow-up of upto 12 months was considered before including them in the study.

**Surgery**

All surgeries were performed by same surgeon (Am A). Conventional phacoemulsification or 700 micron cataract surgery (Microphakonit) (7) was performed (Fig 6 and 7) or coaxial phaco was done. The corneal tunnel was increased with diamond knife or regular keratome to 6.5mm and the IOL was placed in the bag. One patient was pseudophakic and in that case explantation of existing IOL was performed followed by implantation of LMI (Fig 8-10).
2 of the patients had initial loss of lines in the operated eye when measured 1 week postoperatively which had improved at the 1 month follow-up in one patient and at the 6 month follow-up in the other patient. At the end of 6 months, none of our patients had any decrease in distance visual acuity. The mean postoperative distance visual acuity in decimal equivalent at the end of 6 months was 0.133 as compared to 0.067 preoperative values.

**Endothelial density**

The eyes were evaluated for endothelial cell density and loss. The mean endothelial cell count in operative eyes was $3018.33 \pm 513.09$ which at the end of study was found to be $2842.66 \pm 593.01$. The mean change in the operated eye was $-5.79 \% \pm -4.07 \%$.

**Postoperative corneal endothelial-LMI distance**

All the patients were found to have anterior chamber depth within normal range. Photos of anterior segment OCT (Fig 11) shows normal position of LMI and normal anterior chamber dimensions.

**Ease in fundus evaluation**

Fundus evaluation of all patients was done by the same retina specialist in order to grade the difficulty in fundus examination using indirect ophthalmoscope and to assess the possibility of future retinal photocoagulation for peripheral retinal pathology. It was found that the difficulty level encountered was of Grade I in all the quadrants. Good central fundus view was also possible in all the patients.
Grading system for assessing ease of fundus evaluation

Grade 0  No difficulty
Grade I  Ora Seen
Grade II  Ora seen but with problem of glare
  View up to mid-periphery only
Grade III  View up to equator only
Grade IV  Only central fundus seen (disc & macula)

Discussion

Patients with ARMD usually have difficulty in reading and also difficulty in seeing near objects like inability to recognize faces clearly. Other macular pathologies will also cause similar difficulties with varying degree of severity. Optical modalities available to improve the size of the image on the central retina in these patients like low vision aid loops, magnifiers etc. can be used. But this is all at the expense of loss of field of vision and depth of focus. Also the short reading distance, distortion of images, weight & large size are the problems associated with these devices. Some new devices like head mounted video-based image processing system are also available. But the problem of handling, which is the most common cause of failure of low visual aids 16, is associated with them also. Implantable Miniature Telescope (IMT by Dr. Isaac Lipshitz) was used previously with limited success. The new implant is free from the complications associated with IMT.

The LMI is similar to an usual IOL used after phacoemulsification and is fully placed in the bag in a similar way. It provides magnified central image up to 2.5 times the normal while maintaining the normal peripheral vision through the peripheral portion of the lens unlike IMT 17. Because of this it can be used in both eyes of a patient. If there is any further deterioration of the macula, increased magnification can be achieved by adding the plus eyeglasses up to +4.00 D range. There is no relative movement between the eyes and the LMI unlike an external telescope. It requires 6.5 mm corneal incision unlike more than 10mm in the case of IMT thus reducing surgically induced astigmatism 18. In this study we found the postoperative examination of these patients easier with only minimal glare problem due to inadvertent reflection from mirrors. This provides no difficulty for future retinal photocoagulation in contrast to IMT which has limited possible fundus view. Fluorescein angiography results of patients show good visibility of retina up to mid periphery in experienced hands as shown in the photos. Photographs taken through the center of the lens had reflexes due to reflection from the posterior mirror which blocks the visibility of half of the view but those taken from the periphery of the optic after complete dilatation of the pupil had satisfactory retinal view. No significant endothelial loss was noted as the surgery was similar to conventional surgeries for IOL implantation after phacoemulsification and the size of the LMI was quite small as compared to IMT.

References

9. Treatment of Age-Related Macular Degeneration with Photodynamic Therapy (TAP) Study Group. Photodynamic Therapy of subfoveal choroidal neovascularization in age-related macular degeneration with verteporfin; One-year results of two randomized


