

# VisionCare Ophthalmic Technologies Implantable Miniature Telescope

(by Dr. Isaac Lipshitz)

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P050034

Presentation to Ophthalmic Devices Advisory Panel

March 27, 2009

## Presentations

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**Vision Science - Eli Peli, MSc, OD**  
Senior Scientist, Schepens Eye Research Institute  
Professor of Ophthalmology, Harvard Medical School

**Surgical Overview - Stephen Lane, MD**  
Clinical Professor of Ophthalmology, University of  
Minnesota; Associated Eye Care

**Study Protocols - Judy Gordon, DVM**  
ClinReg Consulting Services, Inc.

**Safety & Efficacy - Doyle Stulting, MD, PhD**  
Professor of Ophthalmology, Director of Cornea  
Emory University

**Risk Reduction Strategy - Oliver Schein, MD, MPH**  
Burton E. Grossman Professor of Ophthalmology  
Director, Comprehensive Eye Services, The Wilmer Eye  
Institute

# Vision Science

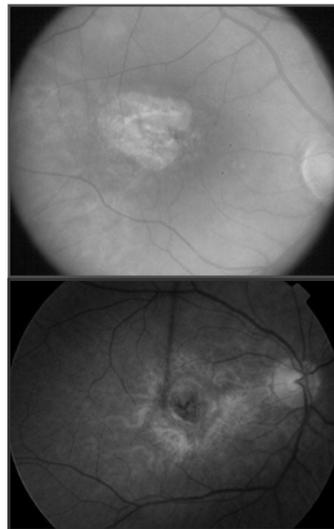
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Eli Peli, MSc, OD

## End-Stage AMD

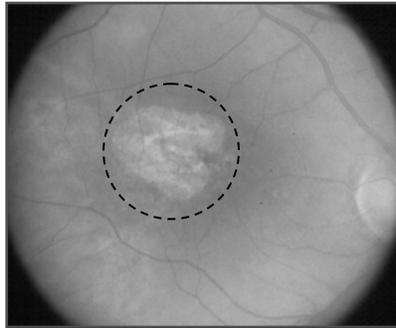
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- A leading cause of vision impairment
- Central vision loss in both eyes due to:
  - Geographic atrophy, and/or
  - Disciform scar



## The Effect of End-Stage AMD

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## Implantable Miniature Telescope

(by Dr. Isaac Lipshitz)

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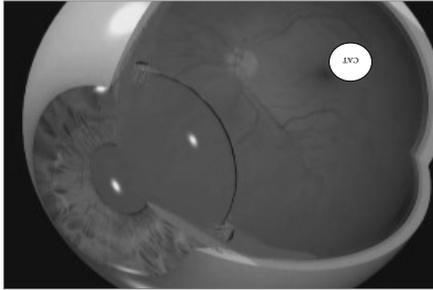
- Optical prosthesis
- Distance & near central vision
- Two models
  - WA 2.2X
  - WA 3X



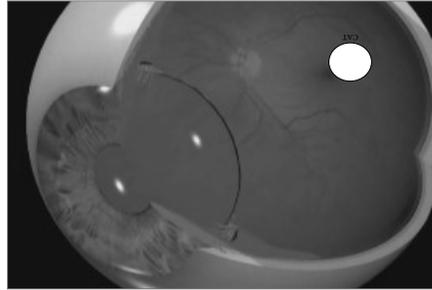
## Vision with Macular Scar

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Image in Scar



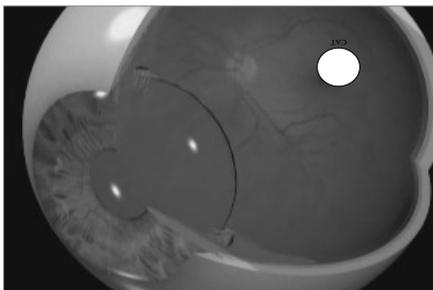
Looking with the PRL



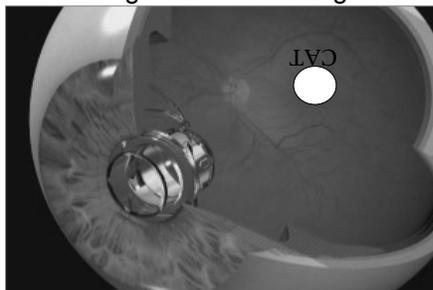
## Effects of Magnification

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Looking with the PRL



Implantable Telescope  
Magnified retinal image



## Intraocular Telescope Advantages

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- Scanning with eye rather than head movement
- No vestibular conflict
- Available on-demand
- Hands-free use
- No stereotyping as disabled
- Compatible with social interaction
  - Eye contact
  - Face recognition

## Intraocular Telescope Advantages

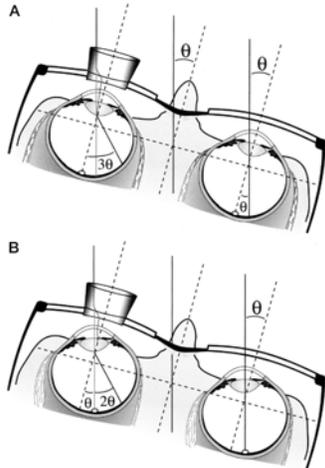
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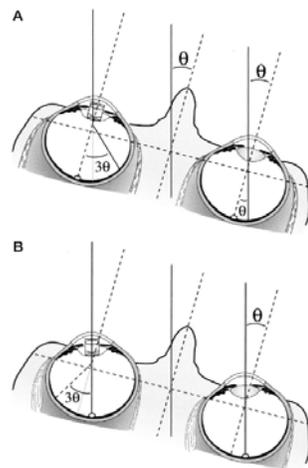
# Impact of Vestibular Reflex

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Spectacle-Mounted External Telescope



Implantable Telescope



Peli E. (2002) The optical functional advantages of an intraocular low vision telescope. *Optometry and Vision Science* 79(4): 225-233

## Intraocular Telescope Advantages

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- Available on-demand
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- Patient not being stereotyped as disabled
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## Intraocular Telescope Advantages

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- Patient not being stereotyped as disabled
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  - Eye contact
  - Face recognition

## Conclusion

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# Surgical Overview

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Stephen S. Lane, MD

## Implantable Telescope

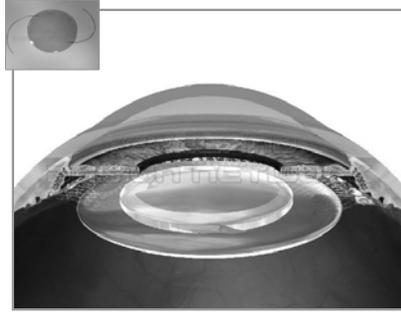
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- Dimensions same in both models
- Optical Tube:
  - Diameter 3.6 mm
  - Length 4.4 mm
- Carrier haptic 13.5 mm diameter

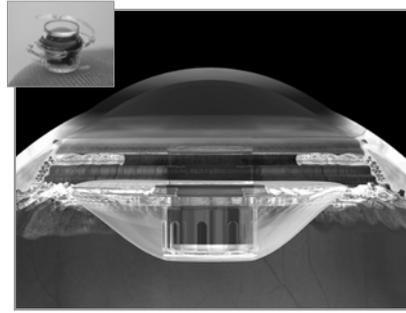


# Geometrical and Surgical Considerations

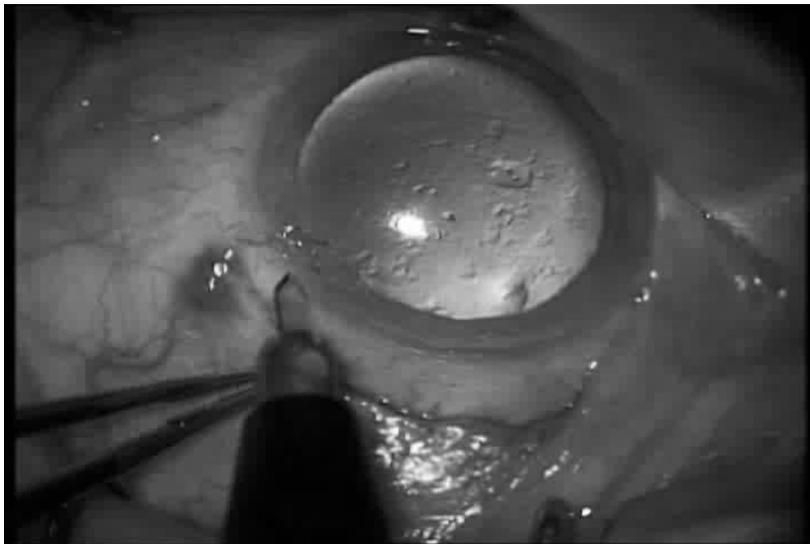
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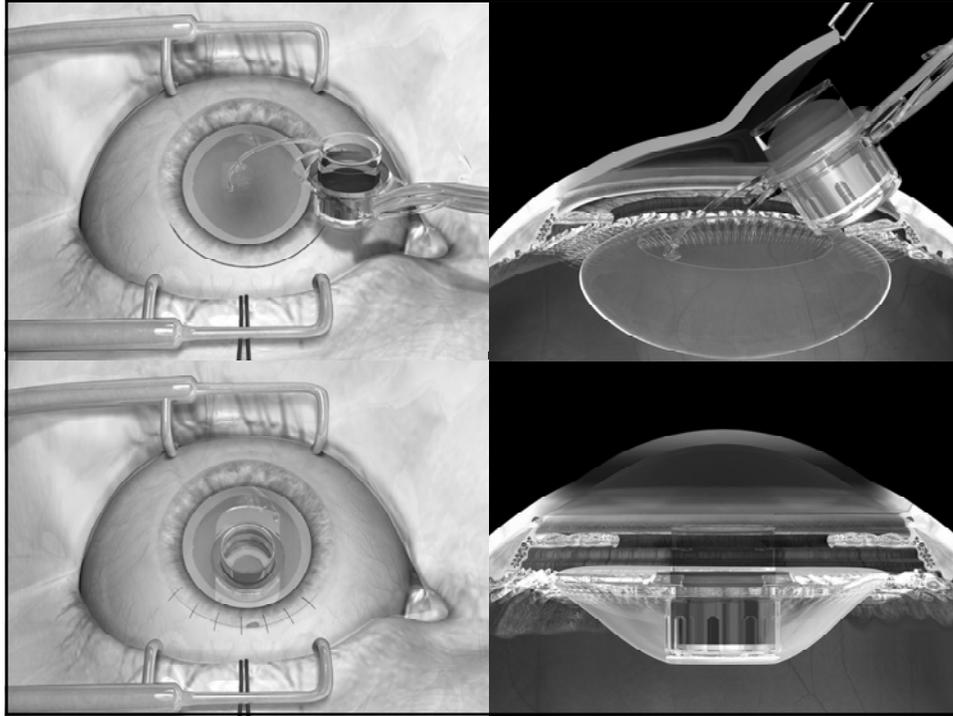


**Standard IOL**



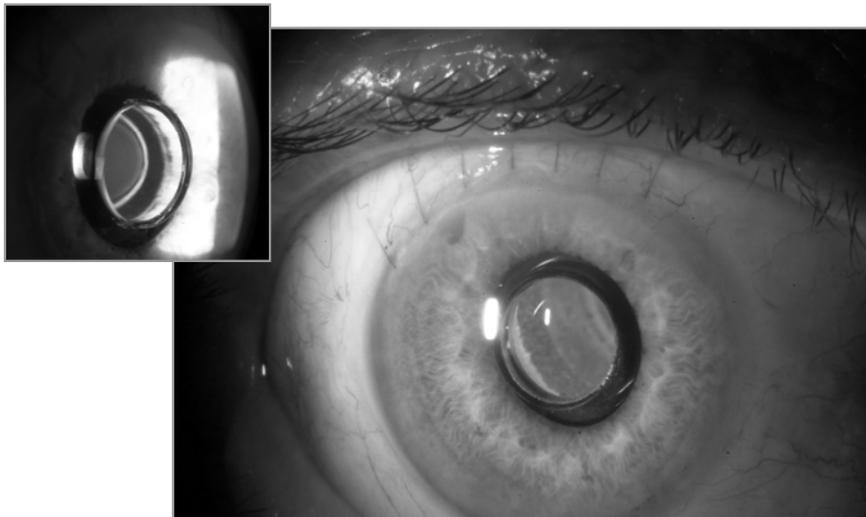
**Implantable Telescope**





## 6 Weeks Postoperative

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# **Protocol IMT-002**

**A Prospective, Multicenter Clinical Trial of the  
Implantable Miniature Telescope (IMT<sup>TM</sup><sub>by Dr. Isaac Lipshitz</sub>) in  
Patients with Central Vision Impairment Associated  
with Age Related Macular Degeneration**

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**Study Design  
Judy Gordon, DVM**

## **Key Inclusion Criteria**

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- Bilateral, stable, untreatable AMD on fluorescein angiography
- Distance BCVA of 20/80 to 20/800
- Presence of cataract
- Adequate peripheral vision in fellow eye to allow for navigation
- Improvement in BCDVA of  $\geq 5$  letters on ETDRS chart with the external telescope in the eye scheduled for surgery
- Anterior chamber depth of  $\geq 2.5$ mm on A-scan

## Key Exclusion Criteria

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- Endothelial cell density <1600 cells/mm<sup>2</sup>
- No corneal stromal or endothelial dystrophies or disorders, inflammatory ocular disease, zonular weakness, pseudoexfoliation, retinal pathology other than stable end-stage AMD

## Protocol IMT-002 - Visits and Parameters

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	Pre-op	Day 7	1 Mo.	3 Mo.	6 Mo.	9 Mo.	12 Mo	18 Mo	24 Mo
BCDVA (ETDRS)	X	X	X	X	X	X	X	X	X
BCNVA (MN)	X	X	X	X	X	X	X	X	X
IOP	X	X	X	X	X	X	X	X	X
Slit Lamp	X	X	X	X	X	X	X	X	X
Fundus Exam & Photo	X								
FA	X								
Pachymetry	X			X	X	X	X	X	X
Specular Microscopy	X			X	X	X	X	X	X
VFQ ADL	X			X	X	X	X		
IMT Training	Weeks 1, 2, 4, 6, 10, and 12								

## Protocol IMT-002-LTM

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### A Long-Term Monitoring Study of IMT-002 Patients

#### Protocol IMT-002-LTM - Visits and Parameters

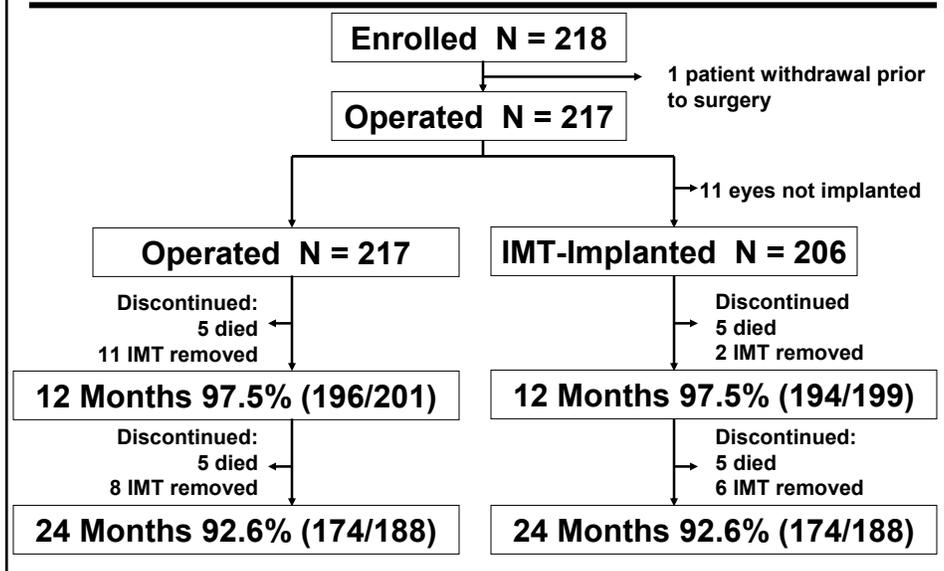
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	Study Entry Visit	30 Mo	36 Mo	42 Mo	48 Mo	54 Mo	60 Mo
BCDVA (ETDRS)	X	X	X	X	X	X	X
IOP	X	X	X	X	X	X	X
Slit Lamp Exam	X	X	X	X	X	X	X
Specular Microscopy	X	X	X	X	X	X	X
Pachymetry	X	X	X	X	X	X	X

**IMT-002 and IMT-002-LTM  
Operated Eyes  
Demographic and Baseline Information**

	<b>IMT-002 N = 217</b>	<b>IMT-002-LTM N = 129</b>
<b>Age (years)</b>		
Mean (SD)	75.6 (7.2)	74.7 (7.3)
Range	55 - 93	57 - 89
<b>Gender</b>		
Female	47.5%	49.6%
Male	52.5%	50.4%
<b>Race</b>		
Caucasian	95.5%	94.6%
<b>Best Corrected Visual Acuity (mean, range)</b>		
Mean BCDVA	20/312	20/307
Range	20/80 to 20/873	20/80 to 20/834

**Protocol IMT-002  
Patient Enrollment and Accountability**



## **Protocol IMT-002-LTM Patient Enrollment and Accountability**

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**174 Operated Eyes Completed  
Protocol IMT-002**



**129 Eyes Enrolled in LTM**

**36 Months 99% (84/85)  
42 Months 93% (113/121)  
48 Months 86% (106/123)**

## **Efficacy & Safety**

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Doyle Stulting, MD, PhD

## Effectiveness

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### **Primary: Visual Acuity**

- Improvement at 12 months of  $\geq 2$  lines in either near or distance BCVA in 50% of implanted eyes

## Effectiveness

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### **Primary: Visual Acuity**

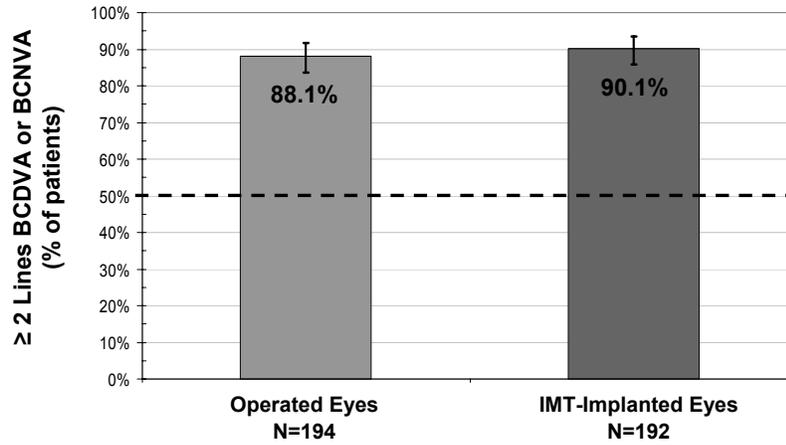
- Improvement at 12 months of  $\geq 2$  lines in either near or distance BCVA in 50% of implanted eyes

### **Secondary: Quality of Life**

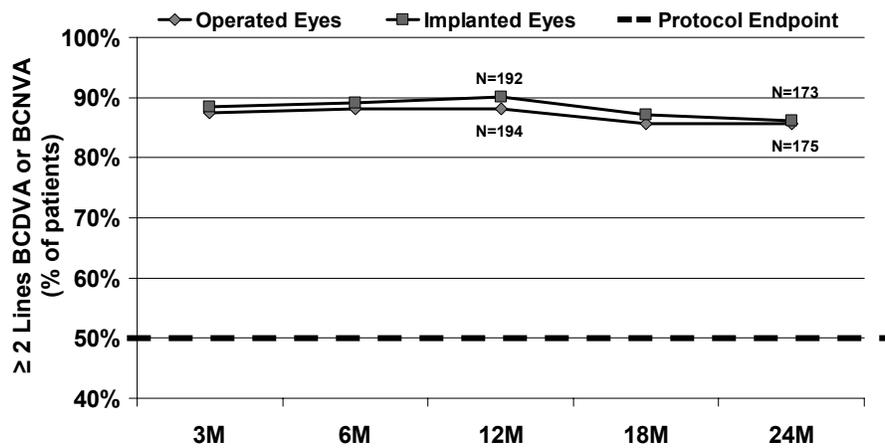
- NEI VFQ-25
- Activities of Daily Life

# Primary Effectiveness Endpoint

## 1-Year Visual Acuity Outcomes

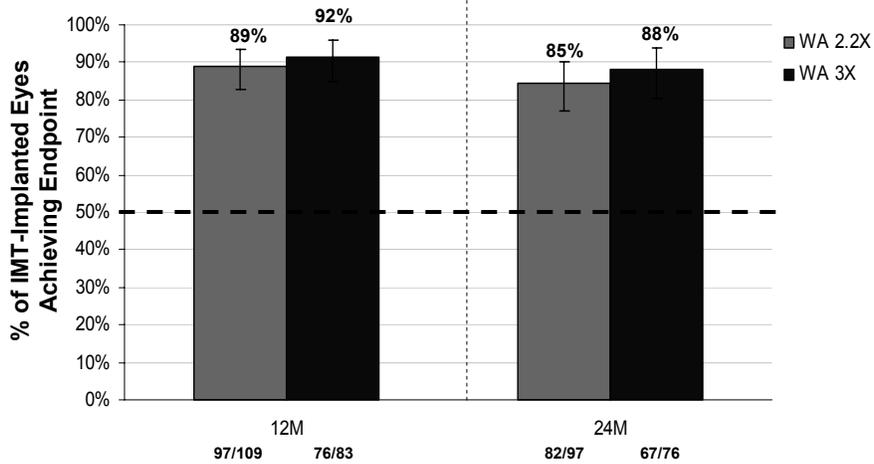


# Primary Effectiveness Endpoint



## Primary Effectiveness Endpoint Stratified by IMT Model

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## Lines of Improvement Summary

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Improvement in Visual Acuity	12 Months N=192 % (n)	24 Months N=173 % (n)
≥ 2 lines gain of BCDVA <u>and</u> BCNVA	73.4% (141)	65.9% (114)
≥ 3 lines gain of BCDVA <u>and</u> BCNVA	53.1% (102)	49.1% (85)

## Lines of Improvement Summary

Improvement in Visual Acuity	12 Months % (n)	24 Months % (n)
<b>BCDVA Lines Gained</b>	<b>N=193</b>	<b>N=173</b>
≥ 2 lines gain of BCDVA	80% (155)	75% (129)
≥ 3 lines gain of BCDVA	80% (128)	60% (103)
≥ 4 lines gain of BCDVA	45% (87)	43% (74)
≥ 5 lines gain of BCDVA	25% (49)	19% (33)
<b>BCNVA Lines Gained (8" or 16")</b>	<b>N=192</b>	<b>N=173</b>
≥ 2 lines gain of BCNVA	83% (159)	78% (134)
≥ 3 lines gain of BCNVA	68% (130)	63% (109)
≥ 4 lines gain of BCNVA	49% (94)	44% (76)
≥ 5 lines gain of BCNVA	29% (55)	24% (42)

## Mean BCDVA

	Baseline		12 Months		24 Months	
	N	Mean	N	Mean	N	Mean
<b>Mean BCDVA (95% CI)</b>	<b>206</b>	<b>20/312</b> (20/334, 20/291)	193	<b>20/141</b> (20/152, 20/131)	<b>173</b>	<b>20/149</b> (20/161, 20/138)

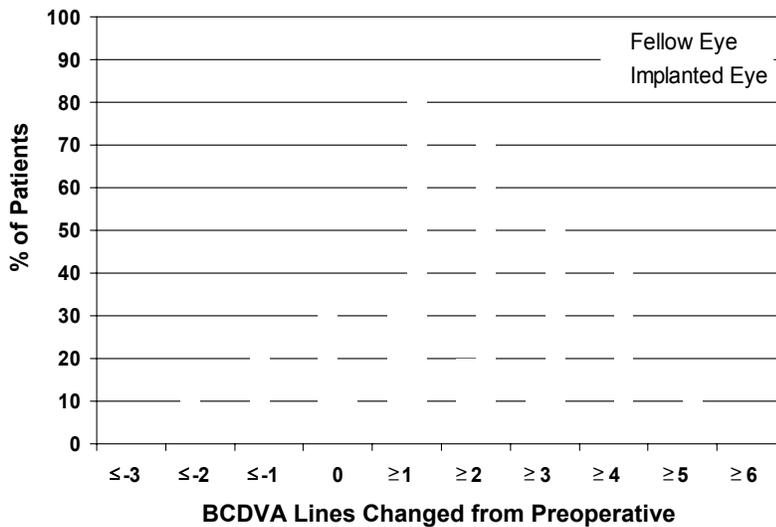
## Line Change by Baseline VA

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Change in Visual Acuity	Baseline BCDVA 12 Months			Baseline BCDVA 24 Months		
	20/80 to 20/160+	20/160 to 20/400	<20/400	20/80 to 20/160+	20/160 to 20/400	<20/400
	% (n/N)	% (n/N)	% (n/N)	% (n/N)	% (n/N)	% (n/N)
<b>≥2 Lines Gain BCDVA or BCNVA</b>	<b>87%</b> (13/15)	<b>86%</b> (99/115)	<b>98%</b> (61/62)	<b>71%</b> (10/14)	<b>84%</b> (87/104)	<b>94%</b> (52/55)

## Distribution of BCDVA Change at 24 Months

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## IMT-002-LTM Visual Acuity

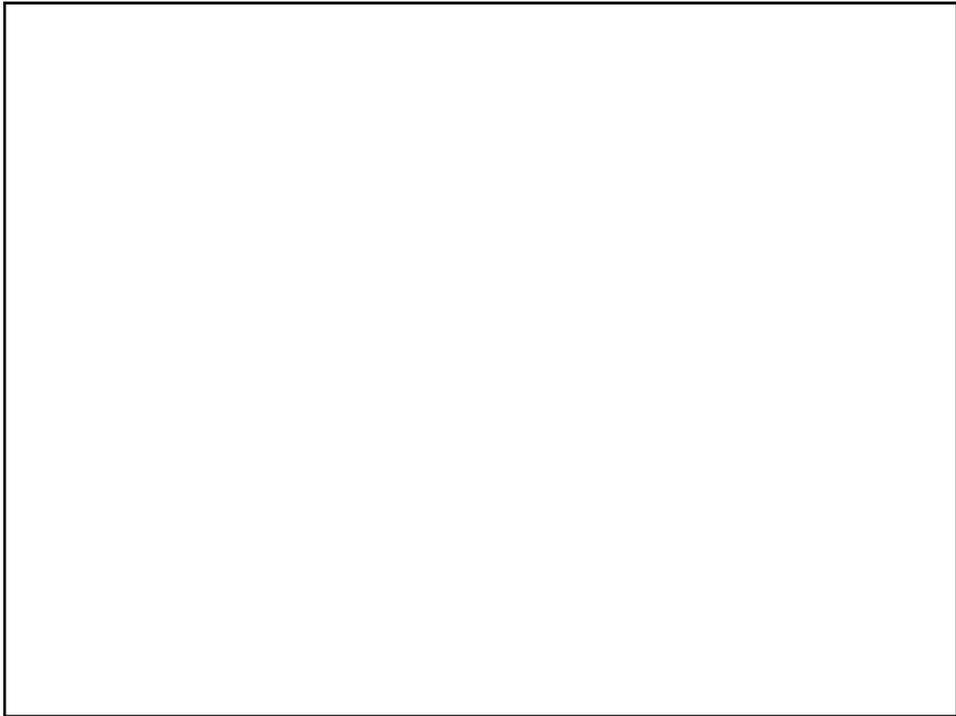
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	36 Months	48 Months
	%	%
<b>Gain <math>\geq</math> 3 lines</b>	<b>53%</b>	<b>48%</b>
<b>Gain <math>\geq</math> 2 lines</b>	<b>69%</b>	<b>68%</b>

BCDVA	Baseline	36 Months	48 Months
<b>Mean</b>	<b>20/312</b>	<b>20/156</b>	<b>20/171</b>
95% CI	(20/334, 20/291)	(20/175, 20/139)	(20/191, 20/152)

## Quality of Life

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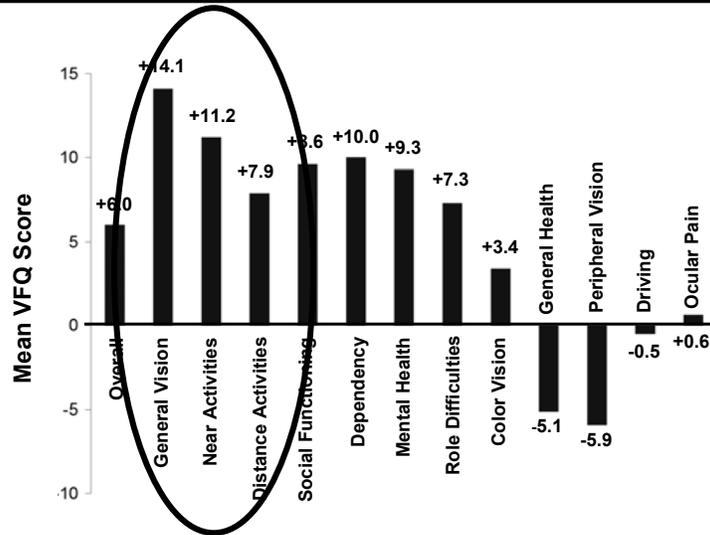


## Quality of Life

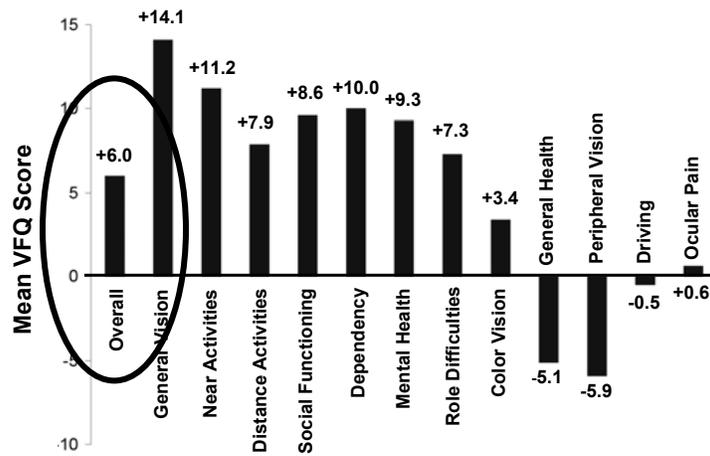
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- **NEI-VFQ (25-Item)**
- **Activities of Daily Life (ADL) Survey**

## VFQ-25 at 1 Year



## VFQ-25 at 1 Year



# Cataract Removal

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# Cataract Removal

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## Change in BCDVA from Baseline Following Cataract Removal and IOL Implantation

	Fellow Eyes of Subjects with Cataract Surgery During Study
<b>N</b>	<b>22</b>
<b>Mean Lines Change in BCDVA (95% CI)</b>	<b>0.35 (-0.60, 1.29)</b>

# Cataract Removal

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## Change in BCDVA from Baseline Following Cataract Removal and IOL Implantation

	Fellow Eyes of Subjects with Cataract Surgery During Study	IMT Eyes with Aborted IMT Implant & with IOL Implant
<b>N</b>	<b>22</b>	<b>9</b>
<b>Mean Lines Change in BCDVA (95% CI)</b>	<b>0.35 (-0.60, 1.29)</b>	<b>0.38 (-0.32, 1.07)</b>

# Cataract Removal

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## Change in BCDVA from Baseline Following Cataract Removal and IOL Implantation

	Fellow Eyes of Subjects with Cataract Surgery During Study	IMT Eyes with Aborted IMT Implant & with IOL Implant	IMT-Implanted Eyes at 12 Months
<b>N</b>	<b>22</b>	<b>9</b>	<b>193</b>
<b>Mean Lines Change in BCDVA (95% CI)</b>	<b>0.35 (-0.60, 1.29)</b>	<b>0.38 (-0.32, 1.07)</b>	<b>3.43 (3.10, 3.76)</b>

# Cataract Removal

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**BCDVA Increase  $\geq 2$  or  $\geq 3$  Lines  
Fellow Eyes with Cataract Surgery and IOL Implant During Study  
And Corresponding IMT-Implanted Eyes**

<b>BCDVA Increase</b>	<b>IMT Eyes N = 22 n (%)</b>	<b>Fellow Eyes (IOL) N = 22 n (%)</b>	<b>McNemar P-value</b>
$\geq 2$ Lines	<b>20 (91%)</b>	<b>6 (27%)</b>	0.0001
$\geq 3$ Lines	<b>16 (73%)</b>	<b>2 (9%)</b>	0.0005

# Efficacy

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## Safety

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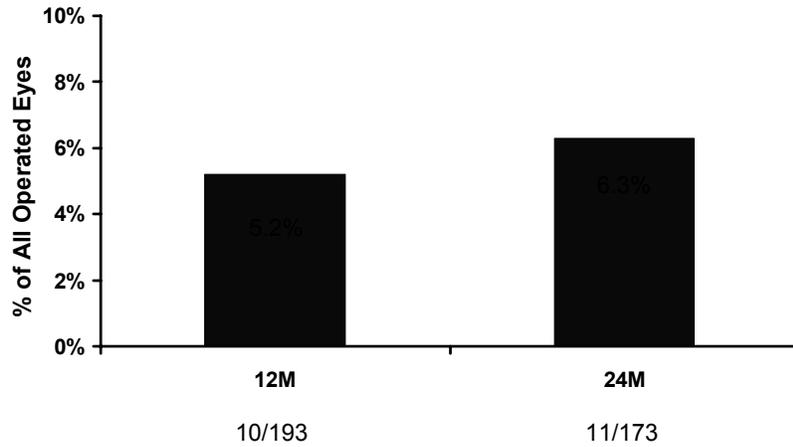
## Safety

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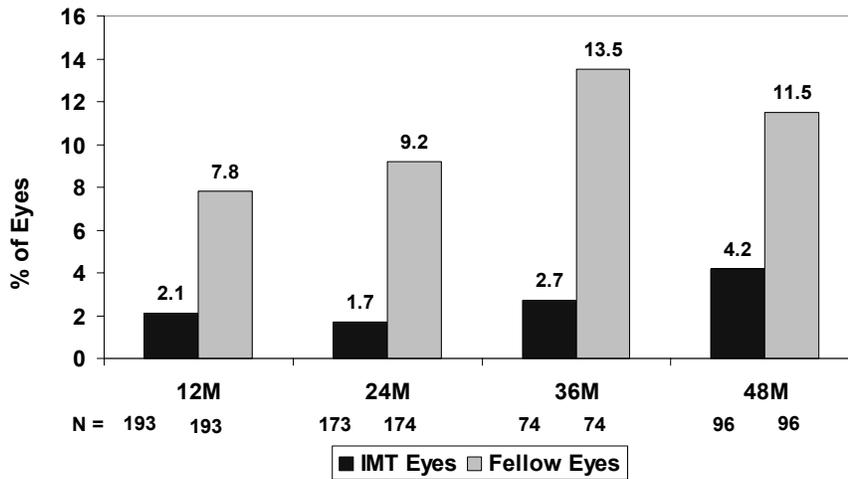
- Best corrected visual acuity
- Endothelial cell density
- Complications
- Adverse events

# Preservation of BCVA

Loss of >2 lines of BCDVA or BCNVA without a Corresponding Gain in the Other



# BCDVA Loss > 2 Lines



## Intraoperative Complications

- Before implantation attempted
  - 3 posterior capsule rupture
  - 2 choroidal detachment
- During attempted implantation
  - 4 posterior capsule rupture
  - 1 zonular dehiscence
  - 1 suspected choroidal hemorrhage

## IMT Explantations

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- 2 device failures
- 2 removed during corneal transplantation
- 8 patient dissatisfaction
  - 3/6 (50%) Stargardt's disease
  - 5/201 (2.5%) AMD

## Corneal Edema

13 operated eyes with persistent edema  $\geq$  90 days

- 1 eye did not receive IMT
- 12 IMT-implanted eyes
  - 3 eyes edema resolved
  - 9 eyes with persistent corneal edema
    - 2 eyes had no loss of BCVA
    - 7 eyes lost vision secondary to corneal edema
      - » 4 eyes had corneal transplantation
      - » 3 eyes had no further intervention

## Corneal Transplants

INTRAOPERATIVE FINDINGS DURING IMT IMPLANTATION	CLINICAL FINDINGS	ECD PRIOR TO CORNEAL TRANSPLANT	OUTCOME OF CORNEAL TRANSPLANTATION
Positive vitreous pressure resulted in iris prolapse	IMT decentered inferiorly Haptic in sulcus Corneal edema	385 cells/mm <sup>2</sup> at 6 months	Standard IOL placed Graft clear and eye quiet
Iris prolapse prevented capsular bag visualization; IMT placed in sulcus	Anterior chamber flattening, 2+ corneal edema on Day 1	463 cells/mm <sup>2</sup> at 6 months	Standard IOL placed Graft clear and eye quiet
Iris damage Corneal touch	-	529 cells/mm <sup>2</sup> at 24 months	IMT left in place Recovery uneventful and improvement in BCVA achieved with IMT retained
IMT tilted, superior haptic pressed against the temporal iris	Localized corneal edema in inferotemporal cornea resulting from touch of IMT to endothelium Investigator attempted IMT repositioning against recommendation of sponsor and medical monitor, with further trauma to endothelium, corneal edema, decreased BCVA	2441 cells/mm <sup>2</sup> prior to IMT repositioning  841 cells/mm <sup>2</sup> Post-repositioning  No ECD reading available immediately prior to corneal transplantation	IMT left in place Recovery uneventful and improvement in BCVA achieved with IMT retained

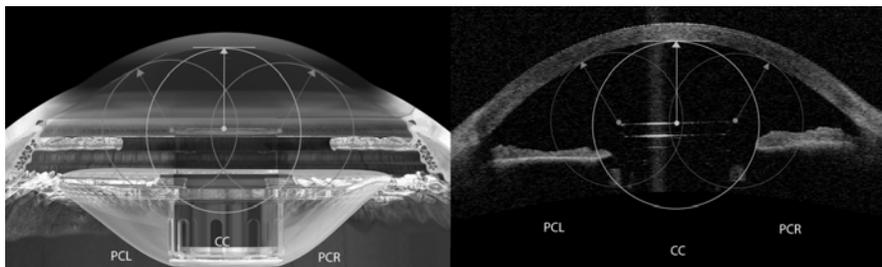
## Other Observations

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- Posterior capsule opacification
  - 12 eyes
  - 11 not visually significant
  - 1 visually significant; vision restored with pars plana capsulotomy
- No reports of
  - Retinal detachment
  - Endophthalmitis

## Postoperative Anatomy

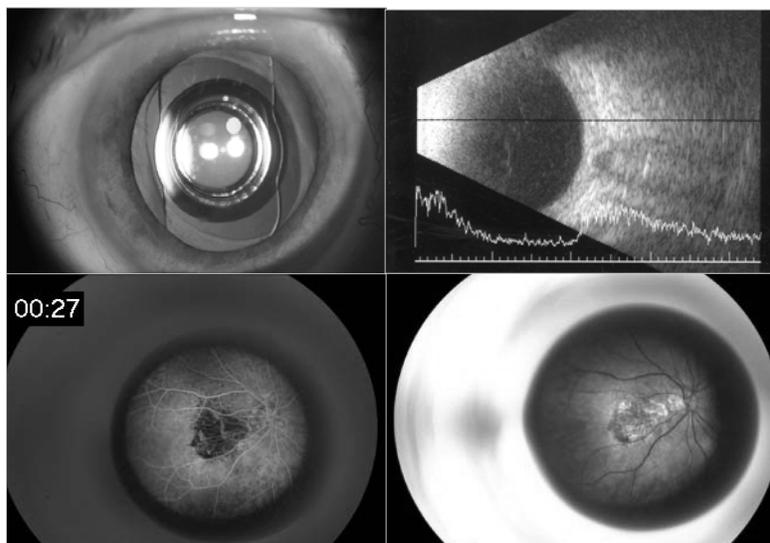
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# IMT Clearance

Clearance Measurement	Distance from IMT to Cornea (stratified by baseline ACD)			
	All Eyes Mean (n)	ACD <3.0mm Mean (n)	ACD ≥ 3 to 3.5mm Mean (n)	ACD >3.5mm Mean (n)
Central	2.51 (45)	2.48 (15)	2.53 (24)	2.53 (6)
Left Peripheral	2.17 (40)	2.13 (13)	2.16 (22)	2.31 (5)
Right Peripheral	2.21 (39)	2.17 (13)	2.21 (22)	2.38 (4)

# Retina Visualization

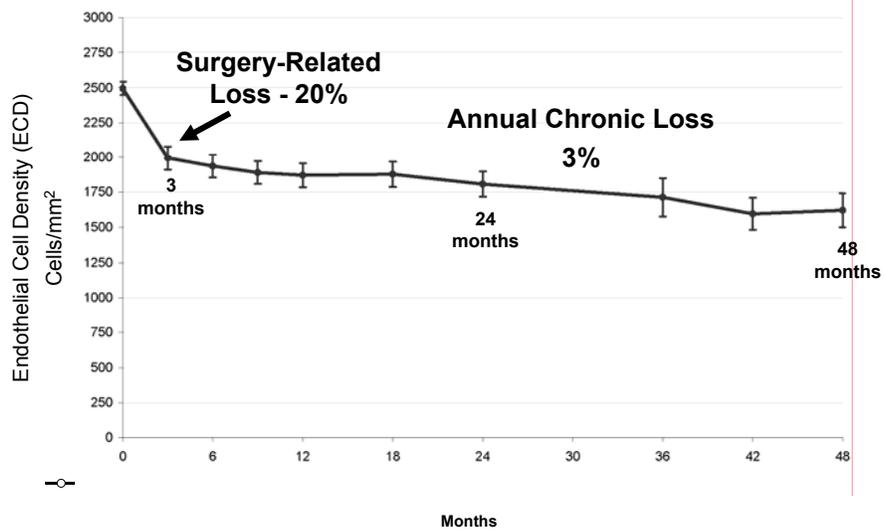


# Corneal Endothelial Cell Density

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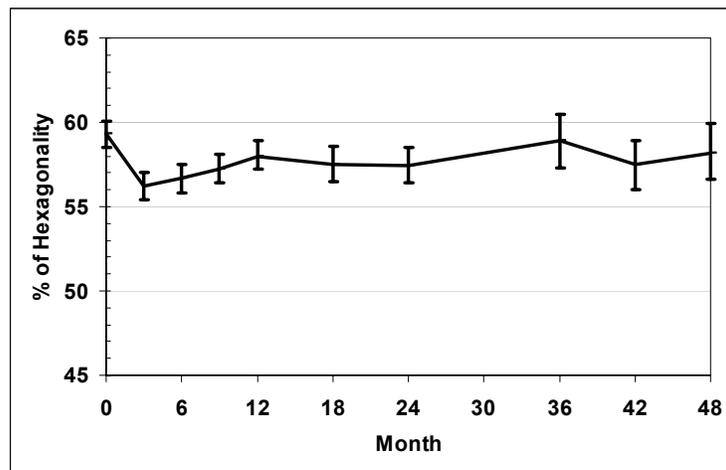
## ECD % Loss

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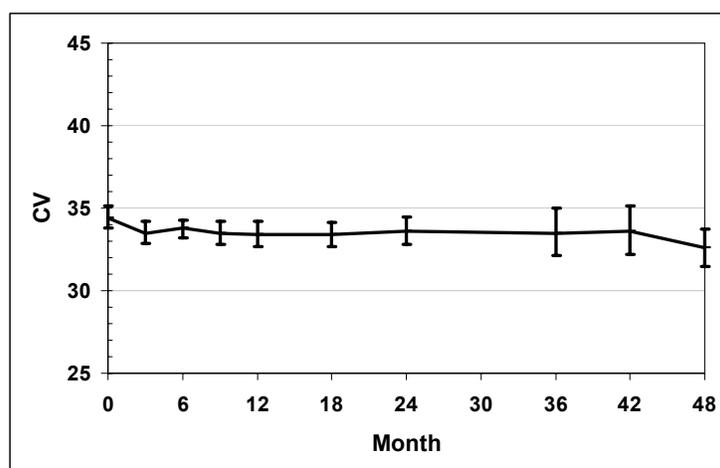
## % of Hexagonal Endothelial Cells

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## Coefficient of Variation

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## % ECD Loss After Cataract Surgery

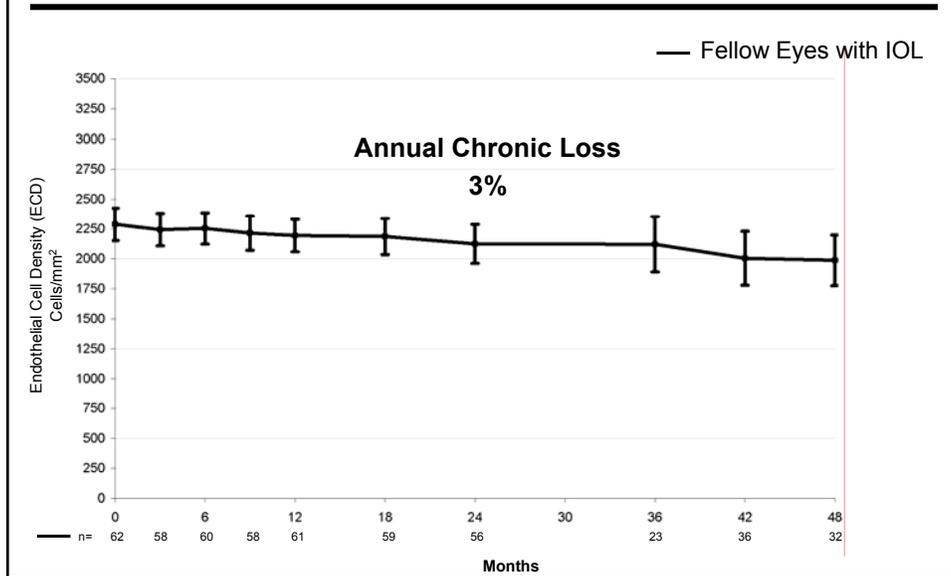
Publication or Study	1 to 6 Months	12 Months	24 Months	36 Months
Liesegang TJ et al. Am J Ophthalmol 1984;97:32-39				
Intracapsular, no IOL (N=20)	13%	16%	22%	
Intracapsular, IOL (N=96)	16%	22%	26%	
Extracapsular, no IOL (N=83)	11%	9%	11%	
Extracapsular, IOL (N=393)	14%	17%	19%	
Bourne WM et al. Ophthalmology 1994;101:1014-1022 N=50	19%	20%		27%
Beltrame G et al. J Cataract Refrac Surg 2002;22:118-125				
3.5mm CCI (N=27)	17%	20%		
5.5mm CCI (N=27)	22%	24%		
Scleral Tunnel (N=27)	17%	19%		
Bourne RA et al. Ophthalmology 2004;111:679-685				
Overall (N = 433)	7%	10%		
Phaco (N=223)		11%		
ECCE (N=210)		9%		

## % ECD Loss After Cataract Surgery

Publication or Study	1 to 6 Months	12 Months	24 Months	36 Months
Liesegang TJ et al. Am J Ophthalmol 1984;97:32-39				
Intracapsular, no IOL (N=20)	13%	16%	22%	
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Phaco (N=223)		11%		
ECCE (N=210)		9%		
IMT-002 & IMT-002-LTM Fellow Eyes Cataract extraction, IOL (N=22)	14%	19%		

## Pseudophakic Fellow Eyes: Chronic ECD Loss

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## Safety

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- Best-corrected visual acuity
  - More than twice as many fellow eyes lost > 2 lines of BCVA than did eyes with IMT implantations

## Safety

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- Best-corrected visual acuity
- Endothelial cell density
  - Acute loss of 25% during first year
    - 5% more than seen after CE in publications
    - 6% more than CE in fellow eyes
  - Chronic loss of 3% per year, no different from fellow eyes undergoing CE
  - 7/206 (3.3%) visually significant edema

## Safety

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- Best-corrected visual acuity
- Endothelial cell density
- Complications
- Adverse events

## Conclusion

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- Valid scientific evidence of efficacy
- Valid scientific evidence of safety
- Benefits exceed risk

## **Risk Reduction Strategies**

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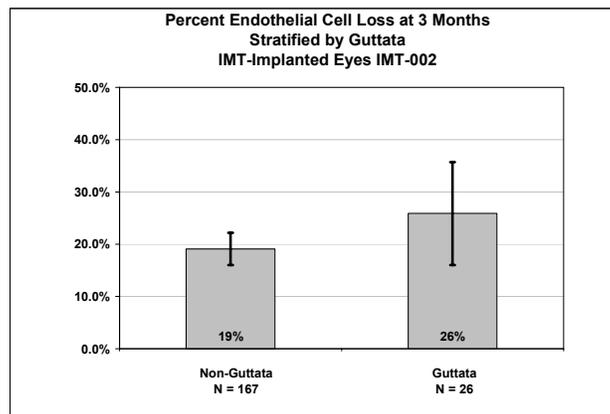
Oliver Schein, MD, MPH

# Baseline Factors Associated with Surgical ECD Loss

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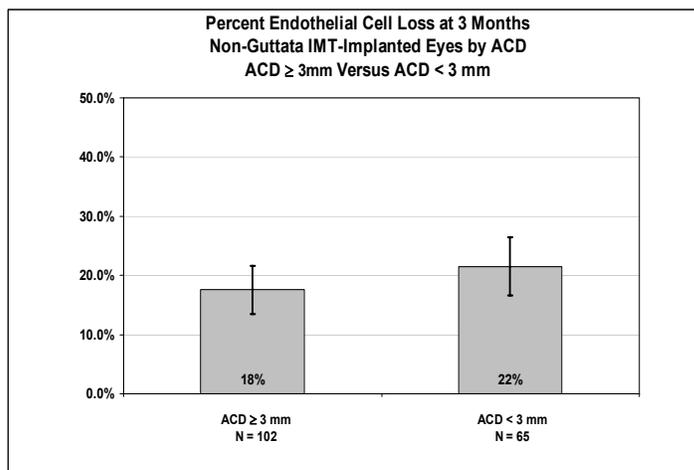
## Guttata

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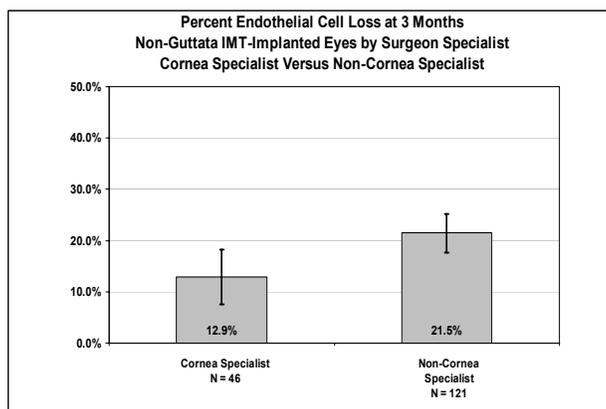
# ACD

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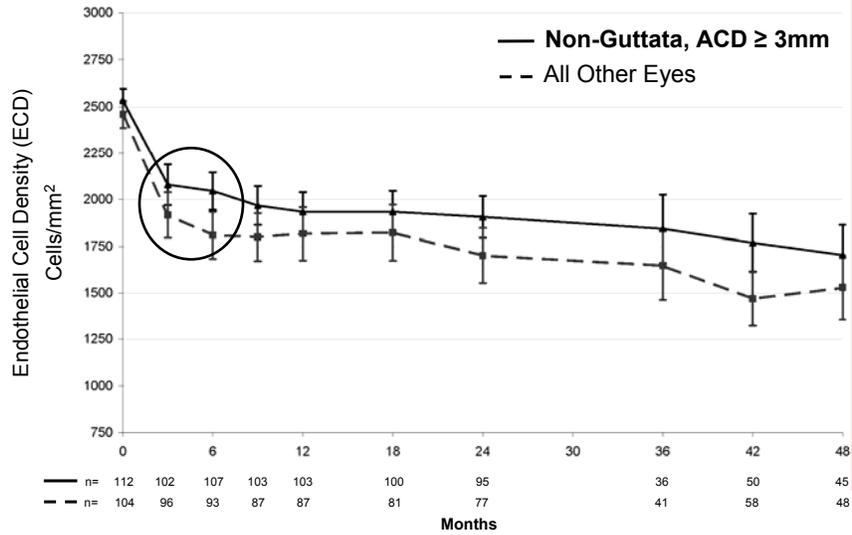


# Cornea Specialist

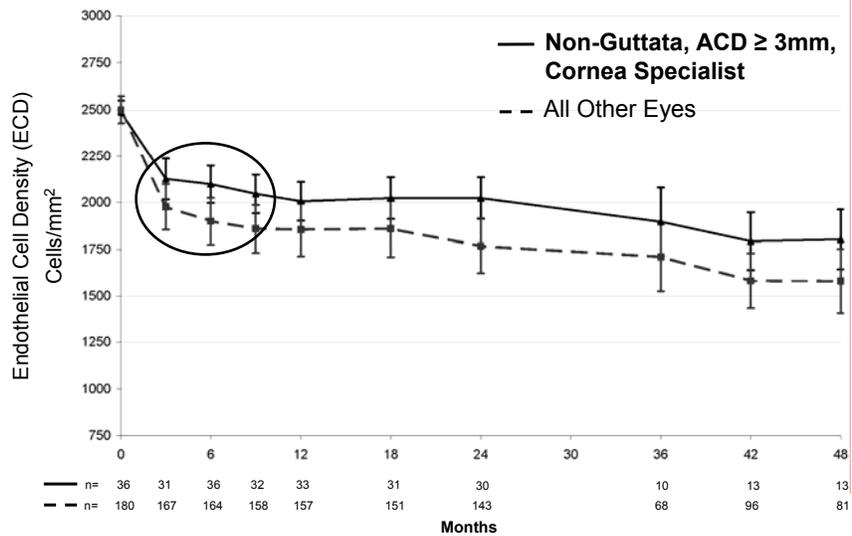
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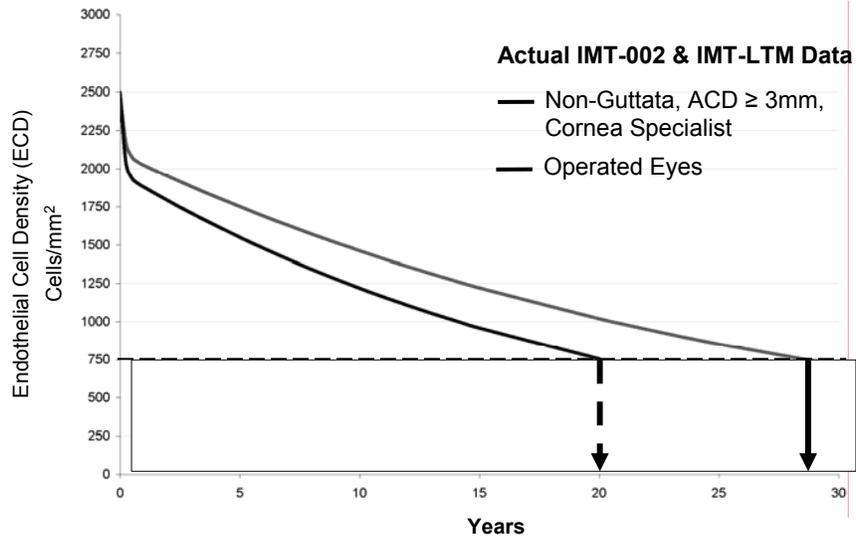
## Risk-Reduced vs. Non-Risk Reduced Cohorts



## Risk-Reduced vs. Non-Risk Reduced Cohorts



# Projected Years to 750 cells/mm<sup>2</sup>



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Risk Reduction Strategies

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## Minimum ECD Decision Grid

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## Minimum ECD Decision Grid

IMT-implanted Eyes

Age Range	65-69		70-74		75-79		80-84	
Gender	Male	Female	Male	Female	Male	Female	Male	Female
Avg. Life Span (Years)	16.6	19.5	13.2	15.8	10.3	12.4	7.8	9.4
Min. ECD	2834	3223	2195	2659	2000	2058	2000	2000

## Minimum ECD Decision Grid

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Non-guttata IMT-implanted eyes ACD  $\geq$  3.0 mm

Age Range	65-69		70-74		75-79		80-84	
Gender	Male	Female	Male	Female	Male	Female	Male	Female
Avg. Life Span (Years)	16.6	19.5	13.2	15.8	10.3	12.4	7.8	9.4
Min. ECD	2460	2755	2000	2325	2000	2058	2000	2000

## Risk Reduction Strategies

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- AC depth  $\geq$  3mm
- 65 years or older
- Follow ECD grid so patient's baseline ECD allows ECD  $>$ 750 for lifespan
- *Cornea trained surgeons*
- *No sulcus fixation*

# SUMMATION

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