



Boston Keratoprosthesis Update

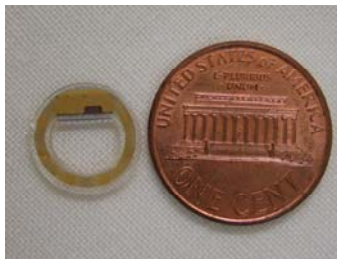
Newsletter VI: 2009

Editor: Rhonda Walcott-Harris

<http://www.meei.harvard.edu/shared/ophtho/cornea2.php>

Intraocular pressure sensors in KPro

Samir Melki, MD, PhD, Miguel Lopez, MD and Claes Dohlman, MD, PhD



Implantable sensor



Telemetry pressure reader

Postoperative glaucoma is still a considerable problem in KPro-implanted eyes, especially in those after chemical burns. Of patients accepted for KPro surgery in Boston, more than two-thirds had glaucoma diagnosed already *preoperatively* and some were aggravated by the subsequent surgery.

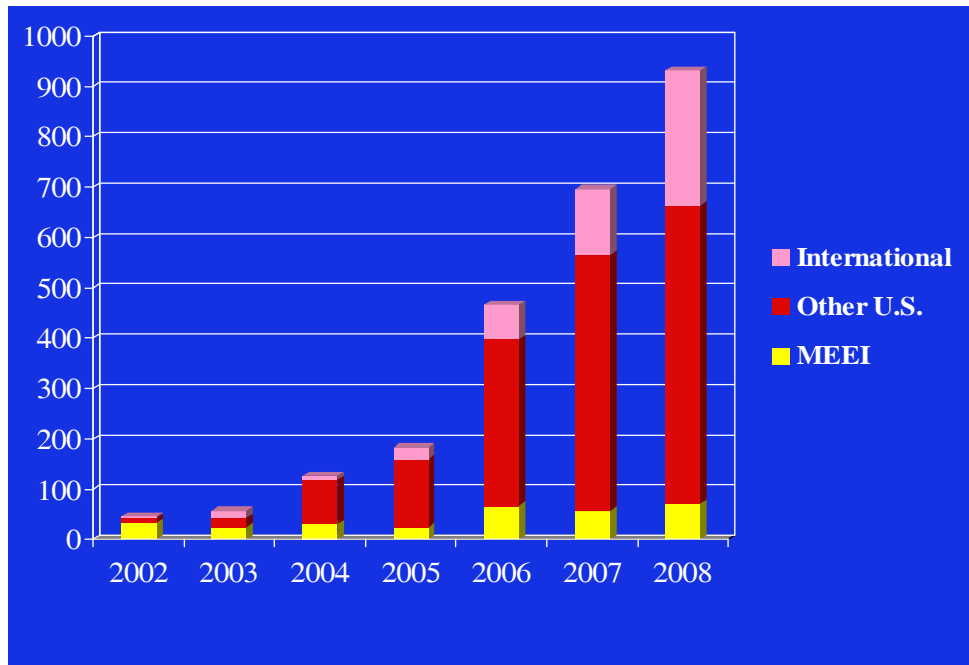
What makes the problem more challenging is the difficulty of measuring the intraocular pressure accurately in an eye with a KPro. In the Boston KPro the stiff back plate prevents measurements based on indentation of the cornea, even in its periphery. Scleral tonometry or the use of any device acting through the lids has in our hands been highly unreliable due to often distorted or scarred tissue structures. For all its vagaries, finger palpation over the upper lid with the patient looking down has arguably been so far the best approach to gross estimation of the IOP.

There is unquestionably a great need for more precise methodology to assess IOP in KPro eyes. An intraocular pressure transducer, that can be monitored from the outside has for a long time been a desirable goal for glaucoma researchers, and animal experiments since 1992 have showed some promise. Miniaturization and long-term stability have been problems, however.

More recently a very small (0.5 mm diameter) pressure transducer was made available, allowing implantation in animals and pressures to be read optically through the KPro by laser interferometry (FISO, Inc., Ottawa, Canada). The device could be attached to the posterior surface of the Boston KPro and the laser beam be aimed directly at it. Although fairly reliable results could be obtained, positioning of the device was problematic and precise readings required very clean anterior and posterior KPro surfaces. (Ma, Belleville, Nouri, Ahmed, Dohlman, ARVO poster 2003)

A recording system based on radiowave telemetry may be more promising. Here the pressure transducers can be placed inside the eye wherever practical. A handheld reader held closely to the eye beams in energy to the device (through clear or opaque media), which in turn signals back the pressure reading. Only recently has a transducer been constructed that is small enough for the human eye and stable enough for long-term intraocular use (Medical Sensors Technologies, Inc., Germany). We have in rabbit experiments found this sensor to give precise pressure readings and to be well tolerated when placed in the sulcus after extracapsular lens extraction (Todani, Melki, Behlau, Fava, Meyer, Dohlman). Also, the system was earlier this year implanted into the first two human subjects, blinded from chemical burn. They were combined with cataract extraction and Boston KPro. The surgery was performed in the Dominican Republic with Dr. Miguel Lopez as the lead surgeon. In the short follow up time, the transducers have been well tolerated. Undoubtedly many modifications will have to be made but eventually such type of IOP recording could be a great bonus in KPro surgery.

Boston KPro Usage 2008



About 3500 devices have been implanted since 1992.

Autoimmune Diseases and KPro Type II

James Chodosh, MD, MPH and George N. Papaliodis, MD



James Chodosh, MD, MPH



George N. Papaliodis, MD

Patients with autoimmune diseases such as mucous membrane pemphigoid and Stevens Johnson syndrome often develop corneal opacities but tend to experience very poor outcomes with traditional corneal allograft surgery. Two physicians at the Mass Eye and Ear Infirmary, Drs. James Chodosh and George Papaliodis, have developed a team approach to such patients that involves a combination of immunomodulatory therapy and implantation of a Boston Keratoprosthesis type II for the restoration of vision. Drs. Chodosh and Papaliodis believe that a multifaceted approach to the care of these patients, before and after surgery, can improve outcomes with the Boston KPro type II.

Drs. Stephen Foster and Claes Dohlman have also accumulated a substantial cohort of such patients.

Drug-eluting Contact Lens

Joseph B. Ciolino, MD



Over ten years ago, it was found that KPro patients benefit from wearing a protective bandage contact lens, which helps to prevent drying of the eye's surface. KPro patients also require the long-term use of antibiotic drops. Because these patients require both a contact lens and topical antibiotics for the best possibility of post-operative success, a team in Boston is working on developing a contact lens that has the ability to release a medication to the eye. Using a prototype contact lens, the initial studies have demonstrated that this feat is possible. The results, showing a steady release rate of an antibiotic for over a month, will be published in IOVS. A multi-institutional team from Mass. Eye and Ear Infirmary (Dr. Ciolino),

Children's Hospital Boston (Dr. Kohane) and MIT are continuing their research on the project. Although KPro patients served as the inspiration for the drug-releasing contact lenses, it is likely that a wide range of ophthalmology patients may benefit from the technology.

Pilot Projects in Asia and Africa

INDIA ...Anthony Aldave, MD



Given the significant social and economic burden of visual impairment secondary to corneal opacification in India, and my interest in India that developed from my first trip in 2002, I became interested in the feasibility of training corneal surgeons there to perform the Boston keratoprosthesis. As I knew well-trained, dedicated anterior segment surgeons at several major institutions across the country, my concern was not whether the level of medical care or facilities available in India were suitable for developing successful keratoprosthesis programs. Rather, I was concerned about whether the hot, humid climate and limited access to care on the part of many potential keratoprosthesis candidates would result in outcomes that were not as good as those obtained in the United States. After speaking with two prominent corneal specialists in India who had expressed interest in starting Boston keratoprosthesis programs at their institutions, it became clear to me that they were sufficiently knowledgeable about the Boston keratoprosthesis and the critical importance of appropriate patient selection to proceed with a formal training course at their respective institutions. Therefore, in January 2008, I traveled to Northern India to the R P Centre for Ophthalmic Sciences, All India Institute of Medical Sciences in New Delhi and to Southern India to the Aravind Eye Hospital in Madurai, providing didactic instruction and live surgical instruction at each location. In February 2009, I returned to India to conduct a formal instruction course at the P D Hinduja Hospital in Mumbai for surgeons from all across Maharashtra, and plan to return to India again in January 2010 to conduct a training course on the Boston keratoprosthesis at the LV Prasad Eye Institute in Hyderabad.

Put simply, the model that I am following is that of “training the trainers”, who are the leading corneal surgeons in India, located in both academic centers and private institutions, who will then train other corneal surgeons to initiate Boston keratoprosthesis programs. The model is working, as evidenced by the fact that surgeons who have been trained in New Delhi and Mumbai have already traveled to other cities in India, such as Kolkatta and Bangalore, to train corneal surgeons there. Equally important as training corneal specialists in India to perform this surgery is the training of all Indian ophthalmologists to identify appropriate candidates in their practices and to recognize and manage post-operative complications. Thus, I have participated in courses on keratoprostheses, speaking on the Boston keratoprosthesis, each of the last several years at the annual meeting of the All India Ophthalmology Society. I have also strongly encouraged the corneal surgeons who have been trained to perform the Boston keratoprosthesis to carefully monitor their post-operative results, and to present their results at local, regional and national meetings, which thus far are encouragingly similar to my published results.

AFRICA ...*Roberto Pineda, MD and Jared Ament, MD, MPH*



Roberto Pineda, MD



Jared Ament, MD, MPH

The June 2009 Ethiopia KPro project successfully added 7 eyes to our study population. A trachoma patient was implanted with a KPro using a corneal autograft. All other eyes required fresh allograft corneas (3 were brought from USA and 4 were from the Ethiopian Eye Bank). Currently, a total of 19 eyes in Ethiopia and Sudan have been implanted with the Boston Keratoprosthesis. Follow-up ranges from this current trip to approximately 18 months. Data reporting via email has been consistent, patient compliance seems adequate, and standardized follow-up regimens are being adhered to appropriately. All-in-all, the project has been a success so far but long-term follow-up and continued support is required.

The purpose of these pilot projects is to find out whether unexpected problems, related to the countries' extremely low resources, will cause problems not seen in the West.

CHINA ...*Tueng Shen, MD, PhD*



Like many developing countries, China faces a big challenge to reduce avoidable blindness among its population. In January 2009, Dr. Tueng Shen was recruited by Orbis International, the U.S. based non-profit dedicated to curing and preventing blindness worldwide. She traveled to China to lead an intensive, one-week training session for ophthalmologists in Yunnan Province, one of China's poorest provinces. There, Dr. Shen led her colleagues through several sight-restoring operations, during which she demonstrated new surgical techniques. She performed the first Boston

keratoprosthesis implant in that country with up to present excellent result. (Also see below)

Dr. Shen returned to China in mid-June to train another group of physicians about the artificial cornea.

Profiles of 3 female KPro surgeons ...

Tueng Shen, MD, PhD



Tueng T. Shen, MD, PhD
Associate Professor
Department of Ophthalmology
Adjunct, Bioengineering
University of Washington
Box 385456
Seattle, WA 98195
email: ttshen@u.washington.edu

Dr. Shen is an ophthalmologist as well as an engineer. She received her PhD in Medical Engineering at MIT followed by her MD from Harvard Medical School. She completed her Residency at the Mass Eye and Ear Infirmary where she was first exposed to the concept and practice of artificial cornea through her mentor, Professor Claes H. Dohlman. She went on to pursue a fellowship in Cornea at the Moran Eye Center (University of Utah). Dr. Shen is building a bridge between engineers and physicians to facilitate the translation of innovative engineering technology to creative clinical solutions. Dr. Shen established an artificial cornea program at the University of Washington in 2004, the first of its kind in the Northwest and has served as the referral center of the five surrounding states. At the same time her research group focuses on the continued development of artificial corneas with specific applications in the developing nations. Her close collaboration with the college of engineering (where she holds an adjunct faculty position) has already led to the development of a variety of medical devices including polymeric drug delivery systems for the eye and new biomaterials for artificial cornea.

Esen Akpek, MD



Esen Karamursel Akpek, M.D. is an Associate Professor of Ophthalmology at the Wilmer Eye Institute, Johns Hopkins University School of Medicine, and the Director of the Ocular Surface Disease and Dry Eye Clinic. She has been on the faculty of the Wilmer Eye Institute since 1999.

Dr. Akpek received her medical training at the Hacettepe University School of Medicine, Ankara, Turkey. Following internship and residency training, she completed ophthalmology subspecialty training in Ocular Immunology and Uveitis at the Massachusetts Eye and Ear Infirmary, Harvard Medical School in Boston, Massachusetts. During her training, she gained extensive

experience in the field of autoimmune and infectious diseases of the eye. Thereafter, she also completed a fellowship program in Cornea, Cataract, and External Disease at the Wilmer Eye Institute, The Johns Hopkins Hospital, to fine tune her surgical skills.

Dr. Akpek specializes in external diseases of the eye. Her clinical expertise includes inflammatory eye disorders, allergic and immunologic diseases of the cornea and the conjunctiva, scleritis, and uveitis. Dr. Akpek performs a wide variety of anterior segment surgeries including cataracts, corneal transplantation and keratoprosthesis, and has patented a novel artificial corneal device.

Kathryn Colby, MD, PhD



Kathryn Colby, MD, PhD is a cornea surgeon at Massachusetts Eye and Ear Infirmary in Boston and an Assistant Professor of Ophthalmology at Harvard Medical School. Following undergraduate work at Johns Hopkins and a PhD in Neurobiology at Brown University, she graduated summa cum laude from the University of Maryland Medical School. Dr. Colby completed residency, chief residency and fellowship at Mass Eye and Ear, where she has been on staff since 1996. Dr. Colby's areas of expertise include Fuchs' corneal dystrophy, novel surgical treatments for corneal diseases, and ocular surface tumors. She has a special interest in clinical research and served for many years as the founding director of the Joint Clinical Research Center, a collaborative endeavor between MEEI and the Schepens Eye Research Institute, Boston, as well as chair of the MEEI IRB. She has numerous publications and is invited to speak nationally and

internationally on both corneal and clinical research topics. She has received a number of awards, including an Achievement Award from the American Academy of Ophthalmology in 2007. Dr. Colby was the first surgeon at MEEI to implant the Boston KPro in children.

Junior Collaborators



*Irmgard Behlau, MD
Research Associate*



*Fabiano Cade Jorge, MD
Research Fellow*



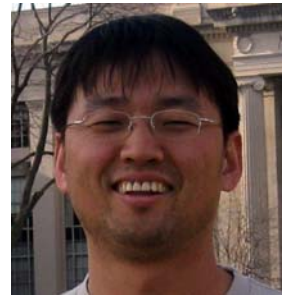
*Jared Ament, MD, MPH
Clinical Research Fellow*



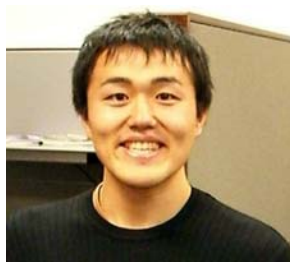
*Jill Beyer, OD
Director, Contact Lens Dept.*



*Liqiang Wang, MD, PhD
Research Fellow*



*Kyung Jae Jeong, PhD
Research Fellow - MIT*



*Michinao Hashimoto, PhD
Research Fellow - MIT*



*M. Stephanie Jardeleza, MD
Retina Fellow*

Recent Boston KPro Literature – 2008 to present

Sayegh RR, Ang LPK, Foster CS, Dohlman CH. The Boston Keratoprosthesis in Stevens-Johnson Syndrome: An Update. *Am J Ophthalmol* 2008;145:438-444

Harissi-Dagher M, Beyer J, Dohlman CH. The role of soft contact lenses as an adjunct to the Boston Keratoprosthesis. *Int Ophthalmol Clin* 2008;48:43

McLellan CL, Ngo V, Pasedia S, Dohlman CH. Long-term stability of vancomycin ophthalmic solution. *Int J Pharm Comp* 2008;12:456-458

Harissi-Dagher M, Colby KA. Cataract extraction after implantation of a Type I Boston Keratoprosthesis. *Cornea* 2008;27:220-222

Garcia JP Jr, de la Cruz, J, Rosen RB, Buxton DF. Imaging implanted keratoprosthesis with anterior-segment optical coherence tomography and ultrasound biomicroscopy. *Cornea* 2008;27:180-188

Pavan-Langston D, Dohlman CH. Boston Keratoprosthesis: treatment of herpes zoster neurotrophic keratopathy. *Ophthalmology* 2008;115:321-323

Aquavella JV. Keratoprosthesis revisited – Current status of keratoprosthesis surgery. *Contemp Ophthalmol* 2008;7:1-8

Aquavella JV. Keratoprosthesis in the treatment of congenital cornea opacity. *Contemp Ophthalmol* 2008;7:1-6

Harissi-Dagher, M, Dohlman CH. The Boston Keratoprosthesis in severe ocular trauma. *Can J Ophthalmol* 2008;42:165-169

Dohlman CH, Colby K, Harissi-Dagher M. *The Boston Keratoprosthesis: Users manual* 3rd ed. Massachusetts Eye and Ear Infirmary, Boston, MA, USA 2008

Waller S, Dohlman CH. The Boston keratoprosthesis. In: Brightbill, F. ed. *Corneal Surgery: Theory, Technique and Tissue*. 4th ed., Mosby 2009;691-696

Sa-ngiampornpanit T, Thiagalingam S, Dohlman CH. Boston Keratoprosthesis in epithelial downgrowth. *DJO* 2009;15:1

Ciolino JB, Dohlman CH. Biological keratoprosthesis materials. *Int Ophthalmol Clin* 2009;49:1-9

Dohlman J, Foster CS, Dohlman CH. Boston Keratoprosthesis in Stevens-Johnson Syndrome: A case of using infliximab to prevent tissue necrosis. *DJO* 2009;15:1-5

Todani A, Gupta P, Colby K. Type I Boston keratoprosthesis with cataract extraction and intraocular lens placement for visual rehabilitation of herpes zoster ophthalmicus: The “KPro Triple”. *Br J Ophthalmol* 2009 Jan;93(1):119 (on-line video)

Aldave AJ, Kamal KM, Vo RC, Yu F. The Boston Type I Keratoprosthesis: improving outcomes and expanding indications. *Ophthalmology* 2009;116:640-651

Rivier D, Paula JS, Kim E, Dohlman CH, Grosskreutz CL. Glaucoma and keratoprosthesis surgery: role of adjunctive cyclophotocoagulation. *Glaucoma* 2009;18:321-324

Bradley JC, Hernandez EG, Schwab IR, Mannis MJ. Boston Type I Keratoprosthesis: The University of California Davis Experience. *Cornea* 2009;28:321-327

Ament JD, Spurr-Michaud S, Dohlman CH, Gipson IK. The Boston Keratoprosthesis: Comparing corneal cell compatibility with titanium and PMMA back plates. *Cornea* 2009;28:808-811

Ciolino JB, Hoare TR, Iwata NG, Behlau I, Dohlman CH, Langer R, Kohane DS. A drug-eluting contact lens. *Invest Ophthalmol Vis Sci* 2009;50:3346-3352

Ciolino JB, Dohlman CH, Kohane DS. Contact lens drug delivery. *Semin Ophthalmol* 2009;24:156-160

Dohlman CH, Grosskreutz CL, Chen TC, Pasquale LR, Rubin PAD, Kim EC, Durand M. Shunt to divert aqueous humor to distant epithelialized cavities after Keratoprosthesis surgery. Risk of Infection. *Glaucoma*, in press

Sayegh RR, Avena Diaz L, Vargas-Martin F, Webb RH, Dohlman CH, Peli E. Optical functional properties of the Boston Keratoprosthesis. *Invest Ophthalmol Vis Sci*, in press

Jun JJ, Siracuse-Lee DE, Daly MK, Dohlman CH. Keratoprosthesis. In: *Cornea and External Eye Diseases*, 2nd ed. [Krigelstein GK, Weinreb RN, eds], Springer Verlag, Berlin, in press

Dunlap K, Chak G, Aquavella JV, Myrowitz E, Akpek E. Short-Term Visual Outcomes of Boston Type 1 Keratoprosthesis Implantation. *Ophthalmology*, in press

Chodosh J, Dohlman CH. Indications for keratoprosthesis. In: Krachmer J, Mannis M, Holland E, eds. *Cornea* 3rd ed., in press

Durand ML, Dohlman CH. Successful prevention of bacterial endophthalmitis in eyes with the Boston Keratoprosthesis. *Cornea*, in press

Harissi-Dagher M, Khan BF, Dohlman CH. The Boston Keratoprosthesis. In: *Corneal transplantation*. Rasik B Vajpayee, editor, Namrata Sharma, Geoffrey C Tabin, and Hugh R Taylor, co-editors. Vajaypee Brothers Medical Publishers. New Delhi, in press.

Saad CG, Ayers BD, Cohen EJ. The Boston Keratoprosthesis in Patients with Autoimmune Polyendocrinopathy. *Cornea*, in press

Ament JD, Stryjewski TP, Chodosh J, Dohlman CH. Cost-effectiveness of the Boston Keratoprosthesis. *Am J Ophthalmol*, in press

Posters (ARVO 2009)

Traux KA, Osgood BJ, de La Cruz J, McMahon TT. Surveillance Cultures of Bandage Contact Lenses of Patients with Boston Type I Keratoprosthesis. Poster # 1494

Pineda R, Ament JD, Tilahun Y, Behlau I, Dohlman CH. Prospective Evaluation of Sustaining the Boston Keratoprosthesis in Developing World: A Pilot Study. Poster # 1497

Cho H, Channa P, Aquavella J. Evaluation of the National Eye Institute Visual Function Questionnaire (NEI-VFQ-39) in People with the Boston Keratoprosthesis. Poster # 1498

Kim BM, Blair MP, de La Cruz J. Macular Optical Coherence Tomography Signal Strength in Boston Type I Keratoprosthesis Patients at the Illinois Eye and Ear Infirmary. Poster # 1499

Nijm LM, Bradley JC, Mannis MJ. Risk Factors for Formation of Retroprosthetic Membrane after Implantation of the Boston Keratoprosthesis. Poster # 1502

Osgood B, Truax KA, McMahon TT, de La Cruz J. Evaluation of Contact Lens Surface after Long-Term Use by Scanning Electron Microscopy in Patients with Boston KPro Type I. Poster #1504

Titanium vs. PMMA Back plates for Boston Keratoprosthesis: Incidence of Retroprosthetic Membrane. Dohlman CH, Todani A, Ament JD, Chodosh, J, Ciolino JB, Colby KA, Pineda R, Belin MW, Aquavella JV, Graney JM. Poster #1505

Retinal Detachments after Boston Keratoprosthesis: Incidence, Predisposing Factors and Outcomes of Repair. Jardeleza MS, Montezuma SR, Dohlman CH, Young L. Poster # 3168

Oral presentation (ARVO 2009)

Todani A, Fava MA, Melki SA, Dohlman CH. Measurement of IOP with Intraocular Pressure Transducer

Abstract of a review to be presented at the Cornea Research Conference on October 9, 2009:

THE BOSTON KERATOPROSTHESIS: WHAT NEXT?

Claes H. Dohlman

About 8 million people in the world are blind from corneal diseases (WHO). With the severe limitations in supply and outcomes of standard corneal transplants, a simple, safe and inexpensive artificial cornea is badly needed.

The Boston Keratoprosthesis (BKPro), a collarbutton-shaped device of transparent plastic, has been under development since the mid-1960's. It was cleared by FDA in 1992. Incremental improvements have included the use of carrier corneal grafts, improving nutrition to surrounding tissues, protection against evaporative damage by constant soft contact lens wear, effective regimens of prophylactic antibiotics (especially vancomycin) and anti-inflammatory drugs, improved locking design, new glaucoma shunts, identification of prognostic factors, etc.

With these changes, tissue melt and infections have become very rare and clinical outcomes have greatly improved. About 3500 BKPros have been implanted worldwide and demand is increasing rapidly. However, glaucoma after chemical burns as well as retinal detachments in autoimmune diseases are still severe problems. Therefore, a broad research team approach presently includes:

- Design and materials changes (titanium etc.), (J G Machine shop)
- Efforts to bond plastics to tissue (Wang, Jeung, Kohane at MIT)
- Develop antibacterial coating of plastic (Behlau, Klibanoff, Gilmore at MIT, MEEI, SERI)
- Analysis of postoperative retinal detachments (Jardeleza, Chodosh, Young at MEEI)
- Optics of various BKPro models (Sayegh, Webb, Peli, et al at SERI)
- Improvement of antifungal prophylaxis (Behlau at MEEI)
- Immunomodulation in autoimmune diseases (Chodosh, Papaliodis at MEEI)
- Contact lenses for protection, drug delivery (Ciolino, Kohane et al at MIT, MEEI)
- Intraocular pressure transducers, read by radiowave telemetry (Melki, Todani, Cade, Behlau, Fava, Lopez at MEEI, Dominican Republic)
- Improved glaucoma shunt valve (Hashimoto, Kohane at MIT)
- Cost-utility studies (Ament et al at MEEI)
- Pilot BKPro studies in Developing World (Pineda, Ament, Chodosh)

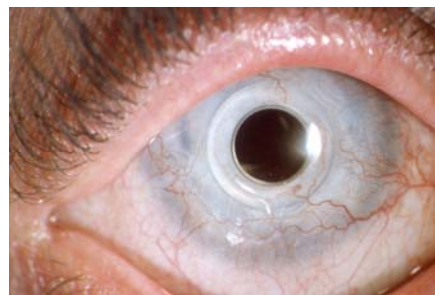
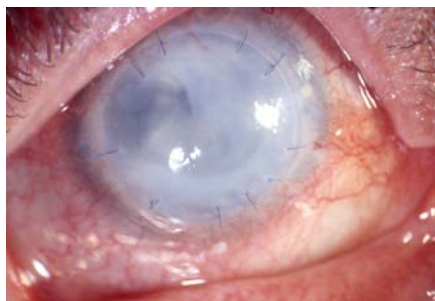
These topics will be elaborated in the poster session.

Invitation to KPro events - 2009

- ❖ **EVER Meeting in Slovenia – A KPro Session** will take place on October 3, 2009.
- ❖ **26th Biennial Cornea Research Conference - KPro talks**, The Starr Center, Schepens Eye Research Institute, Boston, October 9 – 10, 2009:

2009 AAO Meeting in San Francisco:

- ❖ **Boston KPro Users Breakfast** – Monday, October 26, 2009, 7:00 AM – 8:30 AM at the San Francisco Marriott Hotel, 55 Fourth Street, Foothill Room G1/G2. Dr. Claes Dohlman will be the moderator.
For further information contact mlmoar@verizon.net
- ❖ **Boston KPro Course** entitled, “The Boston Keratoprosthesis: What You Don’t Know Will Surprise You” on Monday, October 26, 2009 from 2:00 PM – 4:15 PM in Room West 2020. Dr. Anthony Aldave will be the moderator.
- ❖ **Skills Transfer Course:** “Surgery for Severe Corneal and Ocular Surface Disease”. Dr. James Chodosh will present on the Boston KPro. Sunday October 25, 9:00 AM.
- ❖ **A Breakfast Roundtable** chaired by Dr. Peter Zloty on Sunday October 25, 7:30 AM – 8:30 AM at the Moscone Center West, level 2.
- ❖ **AAO-PAAO Meeting – Symposium: “Cornea: the Cutting Edge, North and South”.** Dr. Kathryn Colby will present “Keratoprosthesis in the United States”, October 25, 2009 at 3:45 PM in the Esplanade Ballroom, San Francisco.
- ❖ **American Society of Ocular Trauma Session:** Dr. Claes Dohlman will present the Helen Keller lecture: “Chemical burns to the eye – what has changed in our approach?” Sunday, October 25, 3:08 PM – 3:28 PM.



From Hand Movement to 20/30 vision (2.5 years postop)

Boston Keratoprosthesis E-Newsletter

Please let us know if you would like to receive the e-mail version of the newsletter or if your mailing address has changed.

E-mail your contact information to: larisa_gelfand@meei.harvard.edu or send via fax: (617) 573-4369 or (617) 573-4324

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