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We wish you a Happy WC 2008!
Past the Polymer Refilling Concept

Ophthalmology’s new *Holy Grail*?

Jean-Marie Parel, Robert Augusteyn, Fabrice Manns, Arthur Ho
Christian Billotte, Viviana Fernandez, Mohamed Aly,
Esdras Arrieta, Adriana Amelinckx,
S Uhlhorn, N Ziebarth, D Borja, A Bernal, E Rosen, T Hughes, L Donovan,
Raksha Urs, K Ehrmann, D Denham, Y Takesue, Sonia Yoo, Brien Holden

*at the Universities of Miami, UNSW, Caen, Melbourne, Cali, Cairo, Los Andes*
*Fukuoka, Liege*

*and the Vision CRC Dynamic Vision for Presbyopes Project Team*

2/21/08

*OBC, CSIRO & Vision CRC*
Etiology of Presbyopia

- Lens content
  - Cortex
  - Nucleus
- Lens capsule
  - Anterior
  - Equatorial
  - Posterior
- Zonules
  - Anterior
  - Equatorial
  - Posterior
- Ciliary muscle
- Brain

Duane (1912)
Ayreshire Group data (with SD .......)
Reported in Borish (1975)
From aIOLs to Lens Refilling to Preservation of Accommodation

- From IOLs to lens refilling
- Lens biology extreme summary
- Preventing Presbyopia and Cataract
- Impact on society
- Time Line
Accommodative IOLs

Crystalens, Eyonics

Tsumotu Hara, 1990

1CU, Human Optics

Sarfarazi a-IOL

Visiogen a-IOL
Accommodating-IOL
Model of Pseudo-Accommodation

Single element

Double element

Courtesy Ho, Pham, Ehrmann, Perera, Manns
Single element a-IOL Optical Modelling

**A-IOL: Modelling for Amplitude of Accommodation**

- **Paraxial Theory**
- **Ray-Tracing (Acrysof)**

![Graph showing pseudo-accommodation amplitude vs IOL position (mm).]

- **1.15 D amplitude**
- **1 mm translation**

Ho et al, *JCRS 2006; 32:129-136*
Zoom a-IOL

Hara et al

Ho et al, *JCRS* 2006; 32:129-136
PCO annihilates RA


Courtesy: PD Lamar, 2000
Phaco-Ersatz 2008

MCV + Lavage + Siloxane + Bubble-Free Cannula + Visible light curing
Phaco-Ersatz in Primates

China 2005

Rh #85045, 20 y/o, POD 6 March 2005

AA: 10.6 D vs 14.6D

Confirmed by the Pharmacia-AMO team
Lens Capsule Refilling

- 1959 Julius Kessler
- 1965 Lavit P Agarwal
- 1980 BPEI team
- 1990 Hara and Nishi
- 2003 Pharmacia team (now AMO)

- 40 years? Still not in clinicals?
IOL and Phaco

- 1765 Chevalier de Tadini
  - *Giacomo Casanova’s memoires*
- 1949 Harold Ridley & 1955 Strampelli
- 1970 Anton Banko and Richard Kelman
- 1985 IOL + Phaco = standard of care
- >200 years !!

What about prevention of cataract?
Lens structure

Anterior epithelium
Zonules
Bow region (nuclei)
Mature fibre cells
Ciliary body
Capsule

courtesy: Robert Augusteyn
Lens growth

$W = 1.33A + 140 \cdot \exp \left(-\frac{97}{A+c}\right) = \text{biphasic growth!!}$

courtesy: Robert Augusteyn
Human lens growth

Wet weight = 1.38A_b + 149\exp(-\exp(1.6-3A_c))

courtesy: Robert Augusteyn
Human lens Weight

Prenatal growth
Wet wt = 149* e^(-e^(1.6-3A_c))

courtesy: Robert Augusteyn

Postnatal growth
Wet wt = 149+1.38Age
Sagittal RI distributions

Augusteyn 2008, adapted from Jones at al
2.5 log units in less than 20 years?

Heys, Leigh and Truscott, 2005
Cataract incidence

% with cataract by Age (years)

- Red: Developing nations
- Blue: Western society

courtesy: Robert Augusteyn
Preventing Cataract

• 1970: “Catalin” era
  – Clinical study, GW Crock, Univ of Melbourne, Australia
  – Later drugs failed as well

• 18 years later the National Foundation for Eye Research led to CCRG
  – Cooperative Cataract Research Group
  – Frank Gibblin summarized research status
    • 2007 Kinoshita lecture
  – Paul J Donaldson: identified intercellular communication pathways using Two-Photons Flash Photolysis and Confocal laser scanning microscopy
What did I Learn?

• Lens epithelium pumps
  – Nutrients/antioxidant throughout the lens
  – Oxidized by-products out of core and cortex

• Lens’ onion structure has
  – 1) channels between the layers of crystalline cells
    • Moieties flow via these layers and through cell membranes
  – 2) holes permitting oxidized by-products extravasation
    • Moieties flow through these holes and through the lens sutures

• Lens growth = compaction = reduction of exchange = cataract

*Lens growth should be prevented!*
Past Lens Refilling?

• Mother Nature didn’t intend us to reach Presbyobic age!

• Preventing presbyopia

• Slowing lens epithelium division
  – Arrest lens growth at 30?
  – Maintain elasticity and clarity?

• Population growing old
  – Huge impact on society
Presbyopia & Population

The graph shows the relationship between accommodation amplitude and age, indicating how presbyopia incidence changes with age.
World Impact

• >60 millions cataracts today = > 1 trillion $

• >1 billion presbyopes = ? $

• Needed:
  – Pharmaceutics to slow/stop lens epithelium growth
    • Topical
    • Controlled Drug Release system
    • Therapeutic Super antioxidants?
    • Non-invasive application?
Time-Line to Standard of Care

- IOL & aIOL: 1765 - 2015 = 250 years?
- Lens refilling: 1960 - 2020 = 60 years?
- Femtosecond lens softening = 2020?
- Presbyopia prevention: 1968 + 100 = 2068?

I will be long dead!
Dynamic High-Resolution Lens OCT

16 year old

Combined with objective accommodometer

Accommodation: OD
Dynamic High-Resolution Lens OCT

>64 year old
Post Phaco-Ersatz

Combined with objective accommodometer

Accommodation:
OD
Restoration of Accommodation requires a better understanding of the biology, optics and mechanics of accommodation.
Accommodation Club
Founded August 19th 1989 to foster research on cataract surgery to preserve and restore accommodation

Nishi, Haefliger, Treffers, Parel

Barcelona 1991
Miami 1992
Barcelona 1997


www.accommodationclub.org