Some of my favorite memories of IIIC, The people, not just the organization.

Never Forget
More memories

Some special people
More

And More
The IIIC Experience

• I don’t like to be in debt to anyone, but the truth is I am indebted to most of you here.

• In IIIC are my friends, mentors, teachers. As I look at this organization, I realize that this is part of our mission: to share, encourage, motivate and challenge.

JAN G. F. WORST, MD

As with other innovators, during his lifetime, Jan Worst’s contributions to ophthalmology would be at first scorned and later heralded worldwide.

Quoting Louis Paufique, Jan said: “One is frequently wrong by being right too early.”
Jan G. F. Worst, MD

- Jan says, “If you want to make your mark in the world, do one thing and do it right.”
- He did two things right, and set new standards with each: The iris supported IOL, and describing the anatomy, and importance, of the vitreous.

- In his first IOL design, Jan secured the iris medallion lens with a stitch, but later included a clasp in the design. This lens evolved into the iris-claw lens, today known as the Artisan lens manufactured by Ophtec.
JAN G. F. WORST, MD

• Of his innovations, Jan Worst stated “I went searching for a needle in a haystack and came out with the farmer’s daughter.”

• Jan Worst: Innovator, surgeon, teacher, humanitarian, iconoclast.

Cataract/Refractive Surgery
Where have we been and where are we going?

A personal and historical review of refractive surgery.

Spencer P. Thornton, MD, FACS
April 22, 2012

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Cataract/Refractive Surgery

• Coincident with increasing interest in small incision cataract surgery (phaco, foldable lenses) was the realization that cataract surgery is, or at least has the potential to be, refractive surgery (toric lenses, LRI, accommodating lenses).
Refractive Surgery Timeline

- **1936-40** Tsutomu Sato observed flattening of the cornea after traumatic eye injury, performed radial incisions external and internal to flatten the central cornea.
- **1948-50** Jose Barraquer began using surgical techniques to reshape the cornea by removing a portion, freezing it, reshaping it with a lath, and then stitching it back into the eye. The portion removed was approximately proportionate to today's LASIK flap.
- **1960's** Radial Keratotomy (RK) was developed by Svyatoslav Fyodorov.

Radial Keratotomy
Radial Keratotomy

Deficiencies and Complications

• Sato (RK) failed to recognize the role of the corneal endothelium, and decompensation resulted.
• Incursions into Optical Zone affected vision.
• Progressive central flattening resulted in overcorrections.
• Overcorrections and undercorrections were common.
Early RK adapters in US

- Leo Bores
- Herbert Gould
- Albert Neumann
- Ronald Schachar
- James Salz
- Gerald Levy
- James Loden
- William Myers
- Norman Stahl
- Dennis Shepard
- Spencer Thornton
- Charles Casebeer
- Jerre Freeman
- Peter Arrowsmith

Early RK Nomograms

- RK nomograms were developed by the early adapters and most were based on Fyodorov’s nomogram. Under-corrections were common, requiring “enhancements”.
- Aggressive surgery led to progressive flattening of the central cornea with over-corrections and hyperopic shift.
- Many improved nomograms for RK and AK followed.
Leaders criticize incisions

"I do not like performing corneal incisions for astigmatism correction (LRI, astigmatic keratotomy). I think that it is not a good procedure because of its low predictability. The femtosecond laser for corneal astigmatism correction may be more reliable."

Vergilio Centurian

Refractive Surgery Timeline

- **1975-79** Development of excimer laser technology.
- **1983** Steve Trokel described use of excimer laser to remove corneal tissue.
- **1987** Theo Seiler performed first excimer treatment on human eye.
- **1988** Marguerite McDonald performed first Laser Vision Correction (PRK).
- **1990** Ioannis Pallikaris performed world's first LASIK (Crete).
- **1991** Stephen Brint performed first LASIK Procedure in US.
Refractive Surgery Timeline

• **1995**  FDA Approved excimer laser for refractive surgery (PRK) to correct myopia with or without astigmatism.
• **1999**  First excimer lasers approved for LASIK surgery.
• **2000**  FDA approved excimer laser for LASIK to correct hyperopia.
• **2002**  Wavefront guided LASIK approved for custom correction.
• **2002**  IntraLase received FDA approval for laser assisted creation of corneal flap.

LASIK

Preferred for higher errors because of progression of RK
Corneal changes with LASIK

Femtosecond LASIK

- While there is no doubt the microkeratome is a great tool for surgeons performing laser eye surgery, the femtosecond laser appears to be more accurate. But complications (transient light sensitivity, irregular flap, ectasias,) still occur.
Femtosecond LASIK

Deficiencies and Complications

• Laser procedures resulted in corneal ectasia and induced astigmatism.
• Dry eyes frequently follow LASIK procedures.
• The search for improvements continued.
Search for Solutions

• The search for solutions included ways to stop or reverse the degenerative changes in the cornea induced by corneal surgery (radial incisions, LRI, LASIK, lamellar keratoplasty), including several surgical and non-surgical modalities (vitamin therapy, UV light therapy, cross linking).

Cross Linking (CXL)

• Progressive irregular thinning is problematic with any LASIK procedure.
• Developed as a new method of strengthening the weakened corneas of Keratoconus, CXL has been shown to strengthen the corneas in post LASIK ectasias and in marginal corneal dystrophies.
• Other uses are being discovered.
Cross Linking

- Cross-linking of collagen refers to the ability of collagen fibrils to form strong chemical bonds with adjacent fibrils. Some naturally occurs in the cornea with aging, but for therapeutic effect, chemical agents (UV activated Riboflavin) are used.

CXL

- CXL has been shown to virtually stop the advancement of ectasia in eyes following excimer laser ablation.
- In an early German study with Corneal Cross Linking, the biomechanical status of the cornea was stabilized with a halting of the refractive and topographic progression of ectasia.

Potential Applications of CXL

Keratoconus and Forme Fruste
Post LASIK Ectasia

Pellucid Marginal Degeneration

CXL Procedure

The cornea is saturated with riboflavin, then illuminated with UVA at a frequency of 370nm, a wavelength which is strongly absorbed by the riboflavin. The riboflavin has a dual action of producing free radicals which cause cross-linking of the stromal collagen, creating new, stable bridges between collagen molecules, reinforcing the corneal structure, strengthening the cornea, as well as acting as a shield to prevent significant levels of UV from penetrating deeper into the eye.
Corneal Cross Linking (CXL)

- The photosensitizer riboflavin and UV irradiance lead to corneal tissue strengthening by increasing collagen covalent bonds, as in photopolymerization in polymers.
- CXL leads to a significant increase in collagen fiber diameter.
- Immunofluorescent confocal microscopy has shown a pronounced compacting of collagen fibers in the anterior stroma after riboflavin and UVA exposure.
Potential CXL Use in Ectasia

• Cases of irregular astigmatism caused by ectasia have been treated by initial cross-linking followed by custom topography-guided surface ablation, with restoration of vision and stabilization of the ectasia with improvement of patients' visual, refractive, and topography outcomes. This method may eliminate the need for corneal transplantation.

Cross Linking and Transplants

• Examining the data over the past ten years, "If cross linking had been available in the United States as it was in other parts of the world, 50% of the corneal transplants could have been avoided."

Potential UV Damage

• “In theory the UVA light could be damaging to the inner endothelial cell layer of the cornea, and this is why the corneal thickness of the stroma needs to be at least 350 µm if a standard CXL treatment is to be undertaken.”

• “Although UVA is potentially damaging to the lens and retina, it is believed that the riboflavin soaking the stromal layer blocks the UVA transmission to an extent that no measurable damage will occur.”
Improvement in HOAs

- Consistent improvement in coma and anterior corneal HOAs seem to indicate validity of the CXL procedure in ectatic cases.


Potential Uses

- Potential uses may include stabilization of corneal biomechanics early-on, before any progression of ectasia is noted.
- Because of FDA restraints, further uses in the US are considered “off label”. Bureaucratic FDA will not recognize “non-US” investigative results.
Complications of CXL

• Possible complications with crosslinking may include Diffuse Lamellar Keratitis, nonhealing epithelium, infiltrates, stromal haze and endothelial disturbances.
• Immediate post-op hyperemia, foreign-body sensation and photophobia usually resolve spontaneously.
• Stromal hazy demarcation lines have been noted at depths of 100 -300 um without significant visual effects.

Few Adverse Reactions

• “The almost complete absence of adverse reactions to the treatment has been confirmed by several studies.
• The failure rate is less than 3% and the complication rate is less than 1%.”

Theo Seiler

• “We remove the epithelium for better efficacy. However, investigators are now producing a new riboflavin preparation with modified physiochemical properties that will be able to penetrate the cornea through the epithelium. ”

Joseph Colin

OCULAR SURGERY NEWS EUROPE EDITION September 1, 2009
Dealing with Problems

- Nothing is perfect or complication free, but complications of CXL appear to be infrequent and manageable.
- Severe pain and visual loss may remain until epithelial regrowth occurs.
- Stromal haze, present during first few weeks, usually resolves within 3 to 6 months.

Transepithelial CXL

- Transepithelial CXL appears to be a major advance.
- Riboflavin is a hydrophilic compound and cannot easily cross the intact epithelial barrier. Buffers and EDTA “enhancers” are added to riboflavin solution to help penetrate through intact epithelium.

Corneal Riboflavin Penetration

- “The epithelium does not significantly restrict the riboflavin penetration. In our series, riboflavin 0.1% was applied to the cornea via a saturated Merocel sponge for five minutes before the start of UVA light administration, and reapplied every three minutes during the whole procedure.”
- “At six and nine months post-op there was no significant difference in the analyzed parameters between the depithelialized group and the non-depithelialized one.”

![Roberto Pinelli](image)

Where are we Going?

(My Predictions)

- RF/UVA Corneal Collagen Crosslinking will become the treatment of choice in stabilizing thinning or unstable corneas.
- Tranepithelial methodology will improve and become standard.
- Further applications and improved methodology will be developed by investigators.
- FDA roadblocks will be reduced by pressure of an informed medical community.
The Future

- FDA acknowledgement of validity of European and other non US studies is imperative.
- The Past is Prologue.
- The FUTURE will be determined by YOU.

There's plenty of excitement ahead, and many discoveries to be made.

- Stay in the Game!