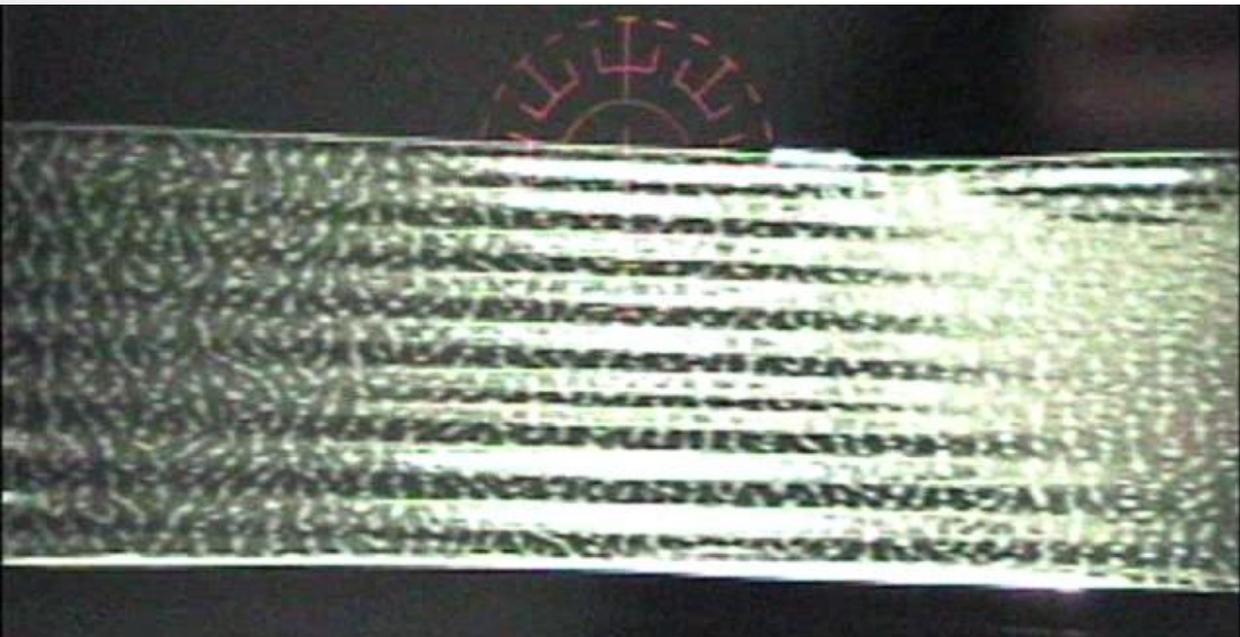


The Physics of Folding in Cataract Surgery

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**The author has no financial interest in the
subject matter of this e-poster**

Purpose: For thin elastic sheets, with stretching, the Föppl-Von Karman equation predicts that fold width is proportional to the square root of the product of thickness and length divided by the fourth root of the displacement (strain) .



Föppl-Von Karman
Equations

$$\lambda \sim (tl)^{1/2} / \gamma^{1/4}$$

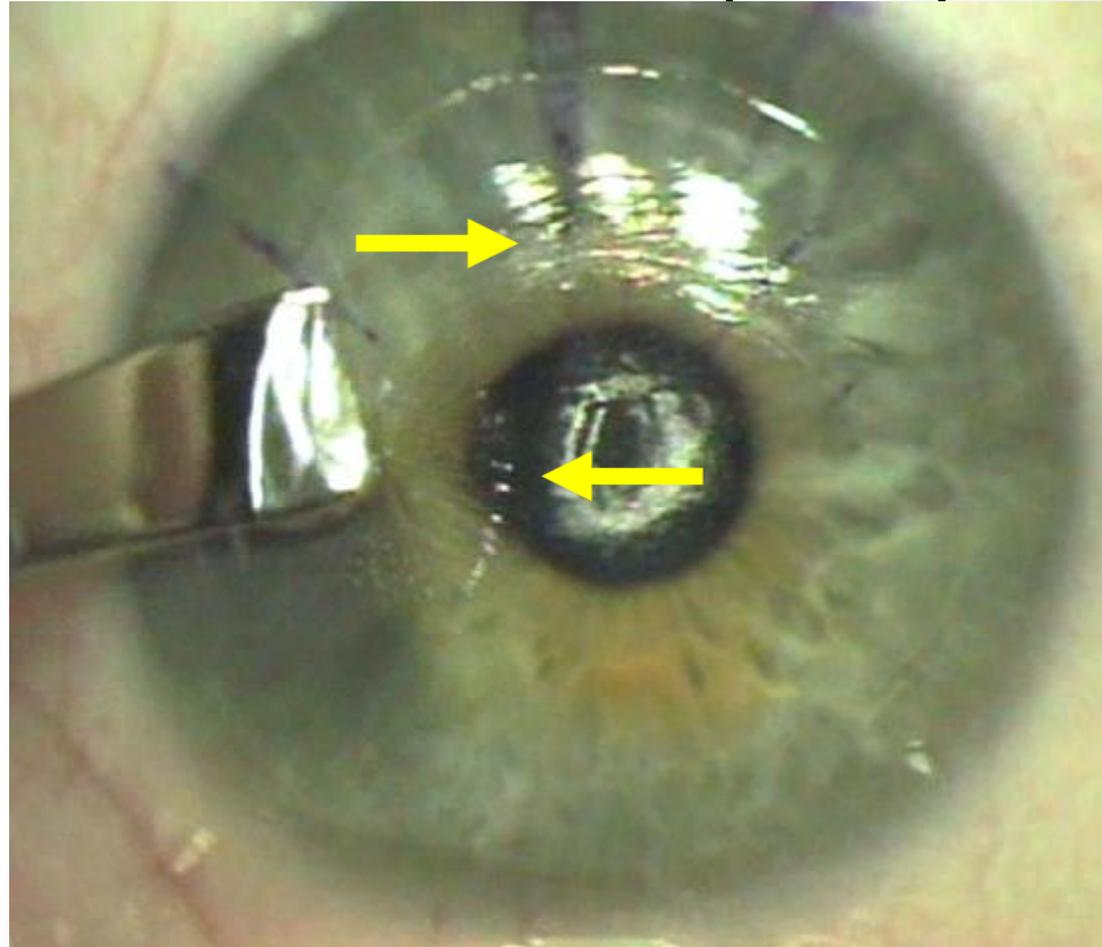
Wrinkling of thin elastic sheets

E. Cerda, K. Ravi-Chandar, L. Mahadevan,
Nature **419**,10, 579 (2002)

Photo shows a stretched 3M Tegaderm

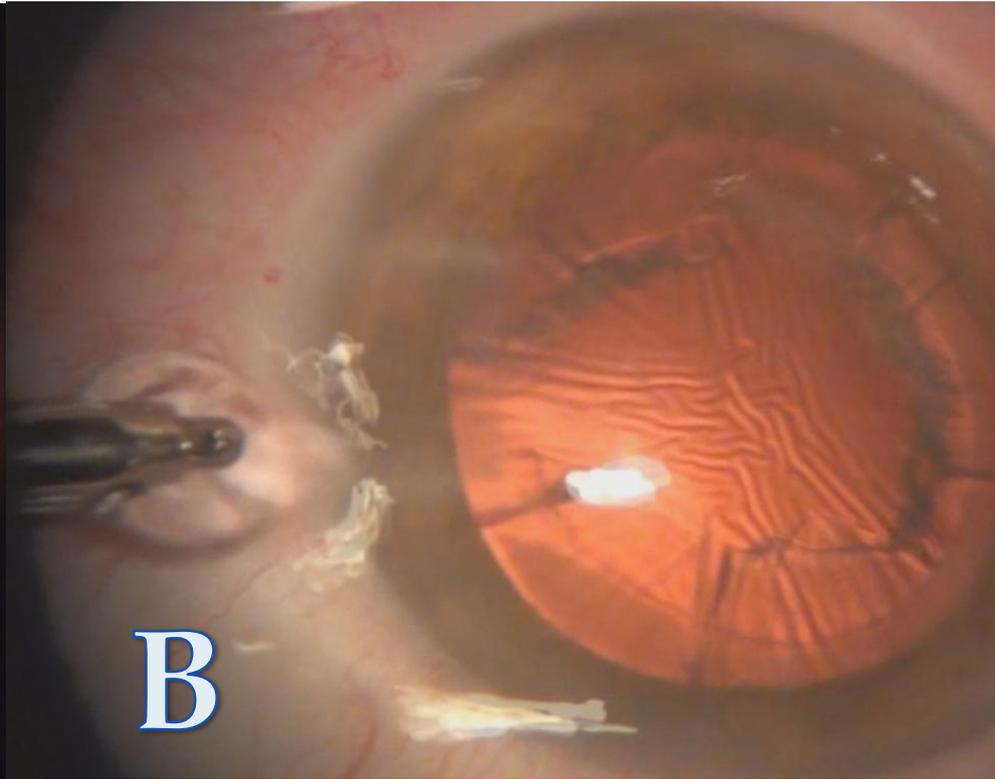
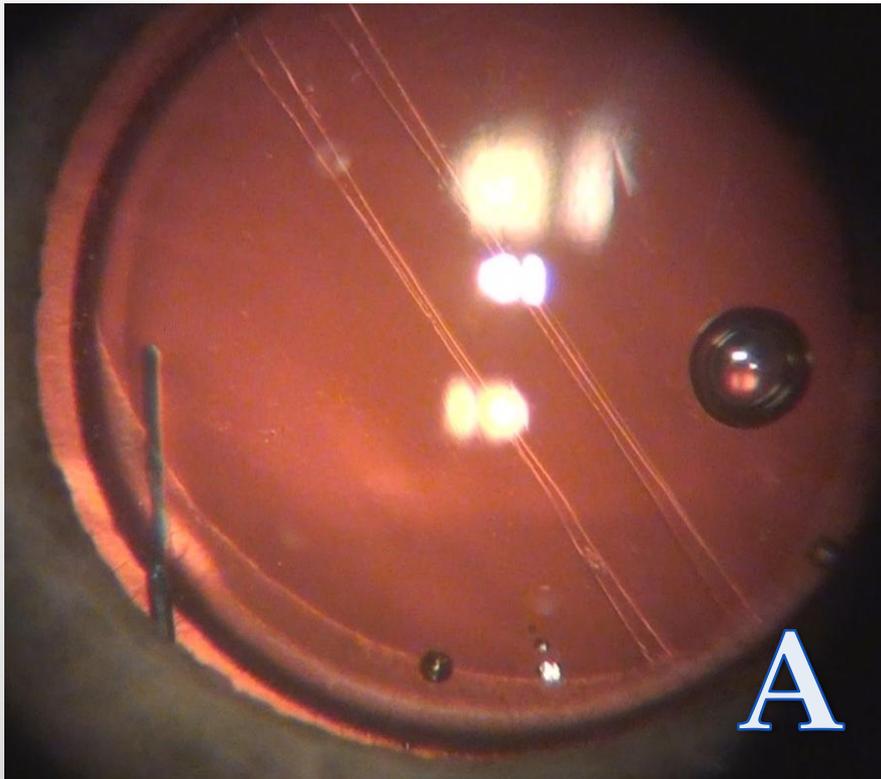
With compression, the width is predicted to be proportional to the thickness of the tissue ($\lambda \sim 1t$)

Routine Lasik enhancement:
The wavelength of the folds is approximately the thickness of the flap



- Geometry and Physics of Wrinkling
E Cerda and L Mahadevan,
Physical Review Letters.
90,074302-1 (2003)

Methods: Recorded cataract surgical videos were reviewed. Fold width and tissue thickness were estimated using the surgical aspiration port as reference. Two examples of folding were commonly noted during cataract surgery: the first (A) was the folds commonly noted in the posterior capsule after implantation of the intraocular lens, the second (B) was cortical folds related to compression on the soft cortical shell by posterior pressure.



Theoretical estimates of folding were made using the thickness of the posterior capsule and the changes in the size of the capsular bag documented in the ophthalmic literature.

- J Cataract Refract Surg. 2004 Oct;30(10):2183-91.
- **Capsulorhexis ovaling and capsular bag stretch after rigid and foldable intraocular lens implantation: experimental study in pediatric human eyes.**
- Pandey SK, Werner L, Wilson ME Jr, Izak AM, Apple DJ.
- *IOVS*, May 2006, Vol. 47, No. 5
- **Human Lens Capsule Thickness as a Function of Age and Location along the Sagittal Lens Perimeter**
- *Rafael I. Barraquer, 1 Ralph Michael, 1 Rodrigo Abreu, 1 Jose ´ Lamarca, 1 and Francisco Tresserra2*

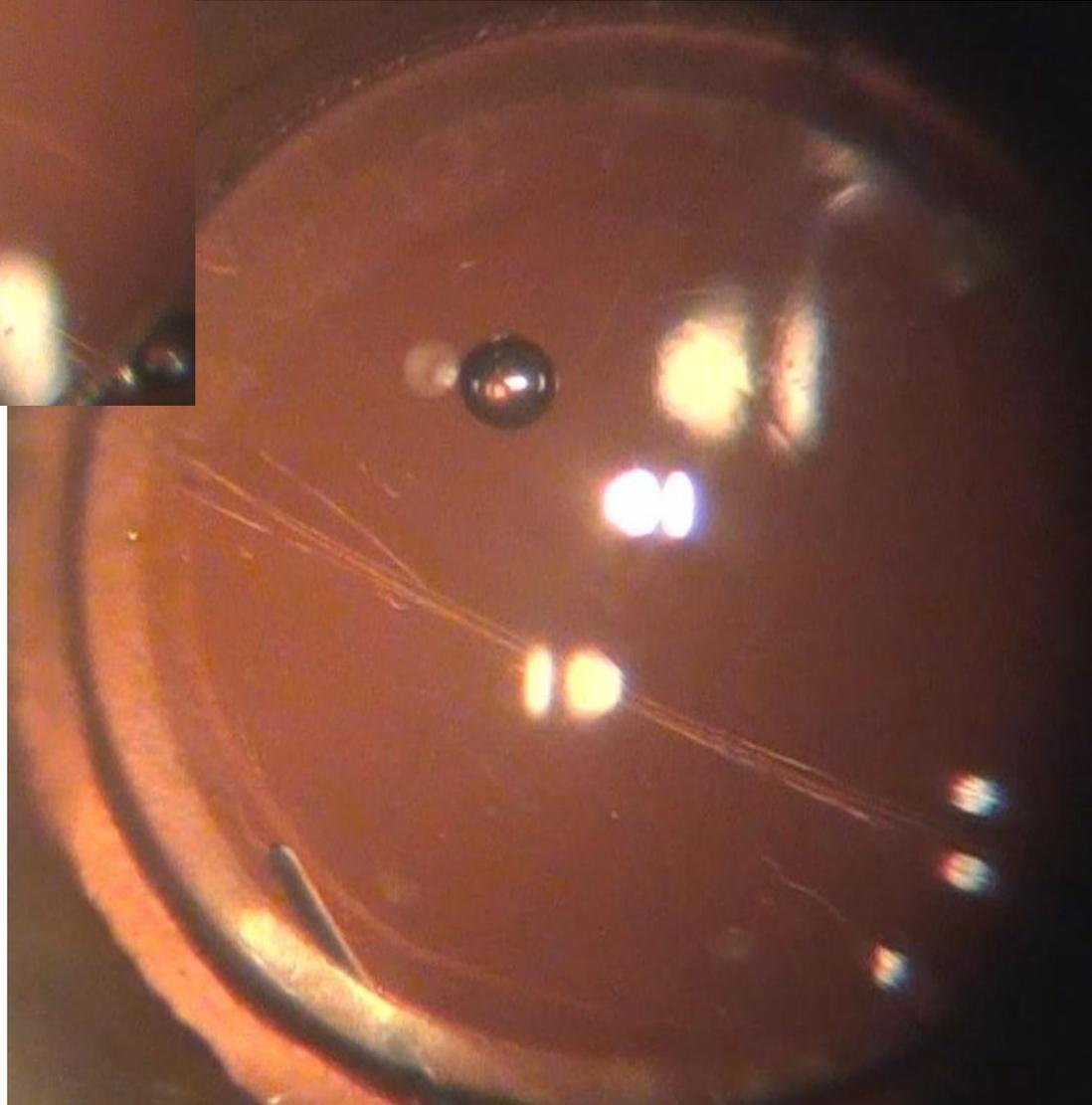
Results: Three cases with folds in the posterior capsule were magnified from the video. The distance between folds was about 60 microns. Using the reported size of the capsular bag with an IOL in place (about 10 by 12 mm) and a posterior capsule thickness of less than 7 microns, the estimated width of the folds is also approximately 60 microns.



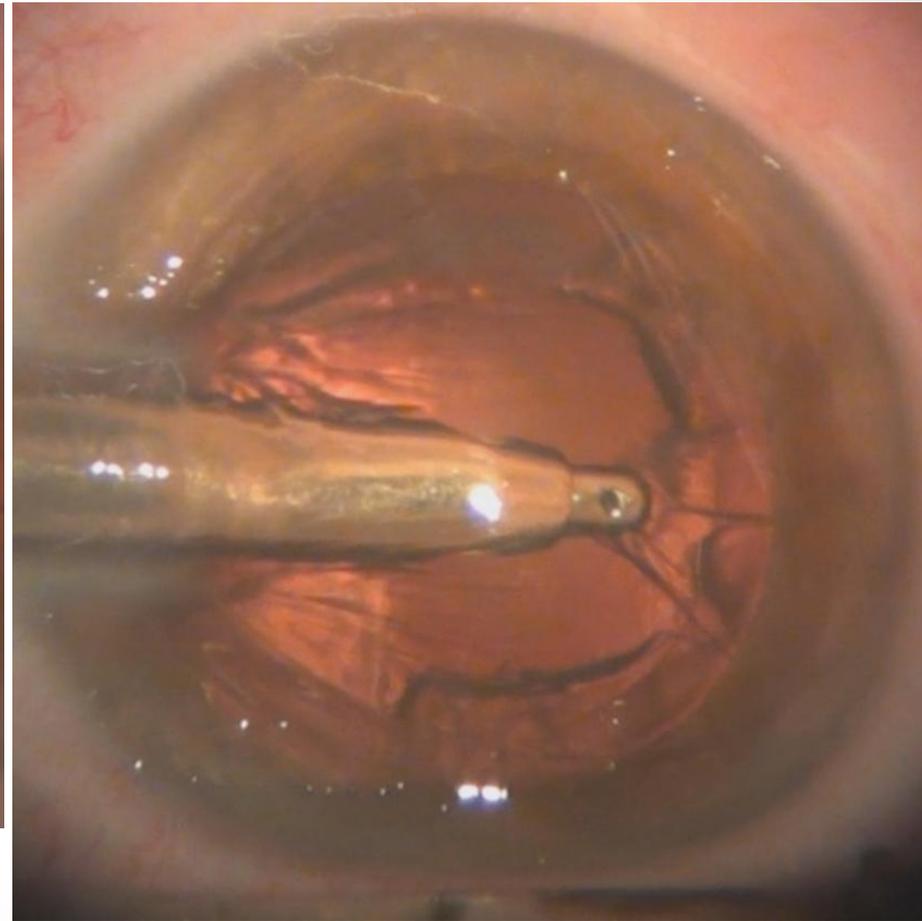
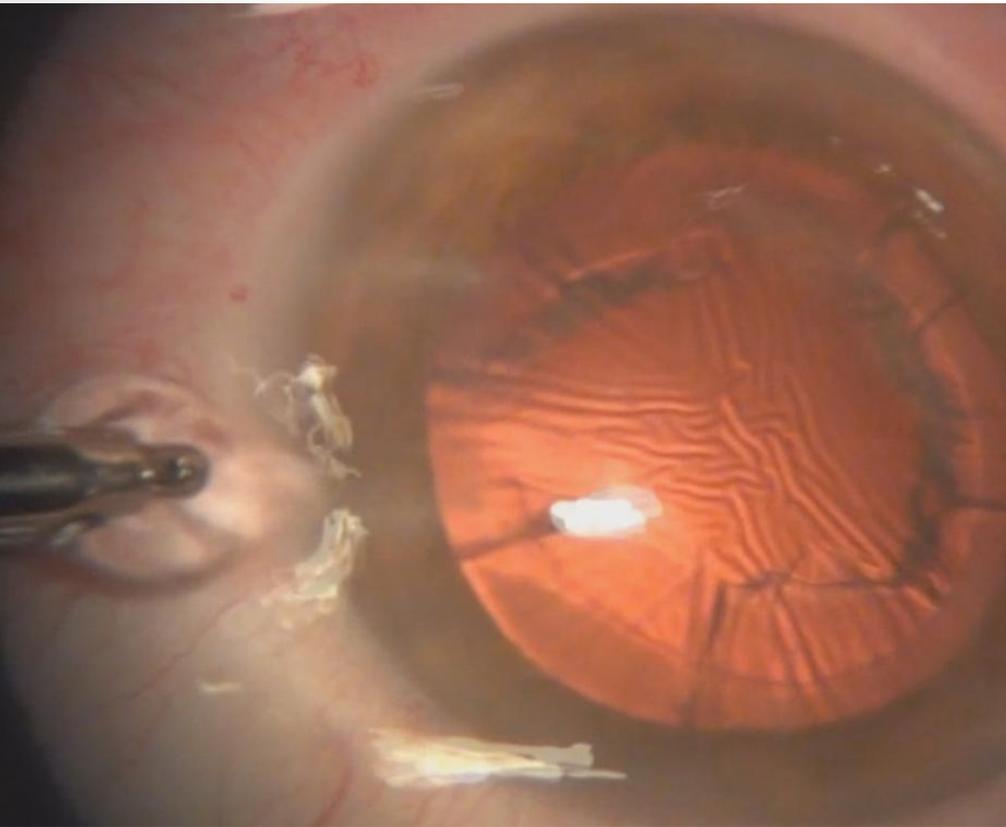


On high magnification each larger fold is noted to consist of multiple smaller folds.

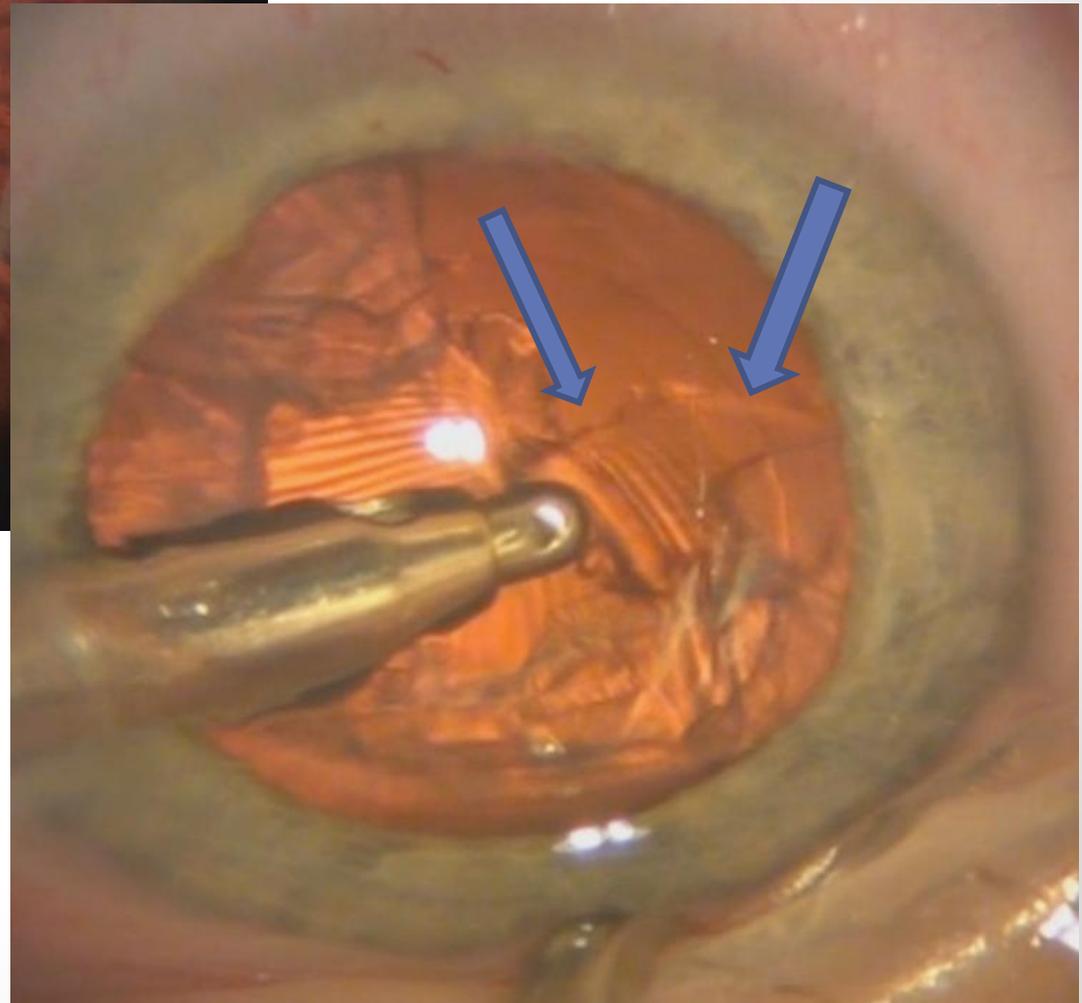
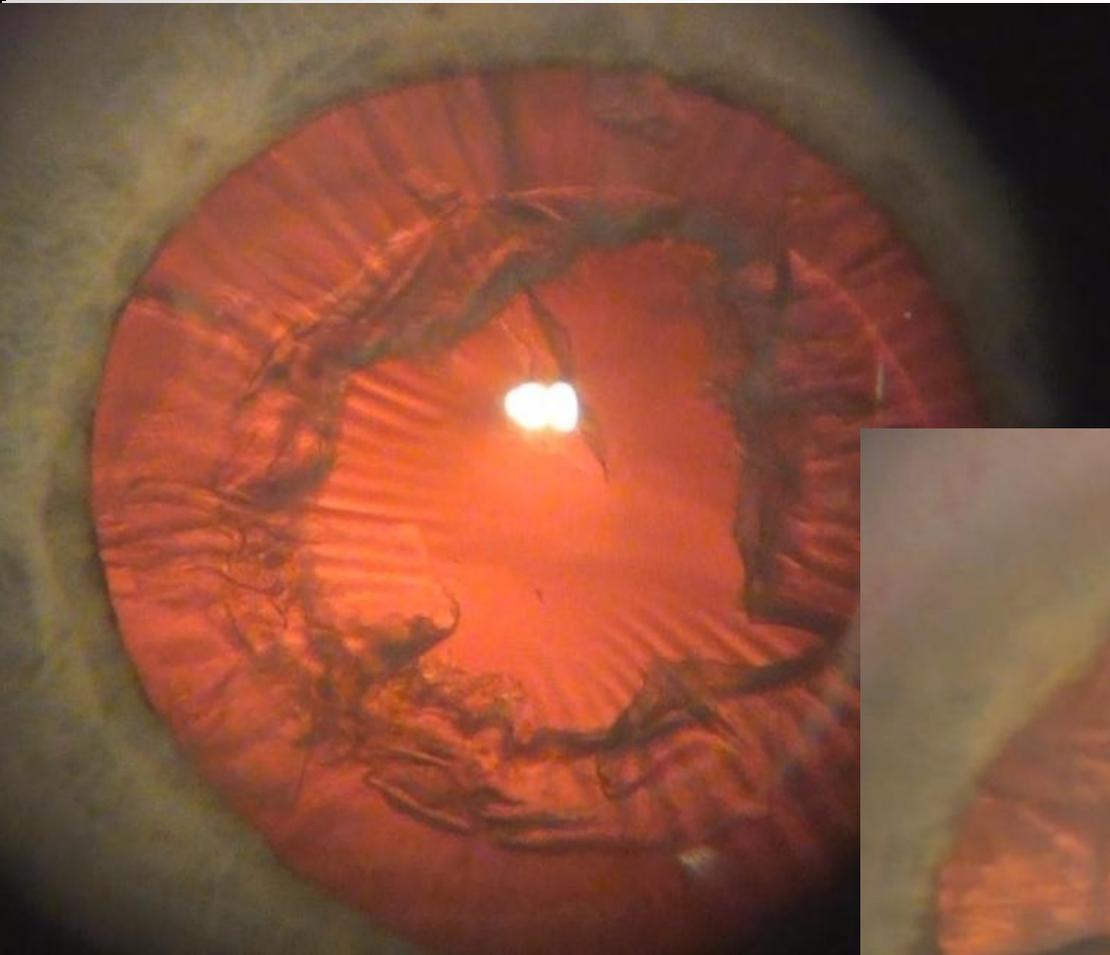
* The haptic width can also be used to estimate the wavelength



Three cases with cortical compression folds were noted. In all cases the width of the folds was approximately the same as the thickness of the cortex.



* Video clips from this case are attached to this poster presentation



The width of the edge of the cortex is comparable to the wavelength of the folds

Conclusion: The observed folds in the capsule and cortex were consistent with the theoretically predicted width. By understanding the physics of folding, surgeons may better understand the stretching and compression forces at work during cataract surgery.

Insertion of viscoelastic into the anterior chamber in a patient with previous hyperopic LASIK. Note that the folds in the anterior cornea have a wavelength consistent with a thick flap.

* A video clip from this case is attached to this poster presentation

