The optomechanics of restoring accommodation with dynamic optics

the

NuLens Experience

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Throughout history, the high morbidity & often grave outcome of cataract surgery reserved it as the last resort for restoring vision ... any vision!
Restoring VISION – Using pure optical solutions

(optical bench)

Aphakic Glasses

IOL or Contact-Lens

Late 20th Century

Mid 20th Century

BC

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The **OPTICAL** power of the accommodating crystalline lens, at any given moment, is the outcome of the **MECHANICAL** balance between the inner crystalline forces and the “eye-wall” anchored ciliary complex – an optomechanical process.
Restoring accommodation is a mechanical task with optical consequences.
• Optical power changes (real accommodation) or focal plan movements (pseudoaccommodation) are the outcome of the mechanical equilibrium dynamics at the AIOL/Capsular interface.

• Regardless of specific optomechanical design, accurate mechanical adjustment at the AIOL/capsular interface is the key for predictable optical performances.

• The calibrated spring action of the AIOL mechanics simulator enables an accurate force measurements at any AIOL/Capsular interface equilibrium.
“In the bag” vs. “On the bag” AIOL positioning – the mechanical perspective

- 30 fresh human cadaver eyes
- Pre-op UBM
- Phacoemulsification
- AIOL mechanics simulator positioned both “In the bag” and “on the bag” in all eyes.
- Second set to confirm results.
- Data analysis of the equilibrium results.
- Data correlation with pre-op UBM measurements.

“Pre-op” UBM

“In the bag” AIOL
Capsular support only

“On the bag” AIOL
Eye-wall support needed

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“In the bag” mechanical interface - Morphology

- The inner surface of the capsular bag is the mechanical interface of any “in the bag” AIOL, regardless of specific optomechanical design.
- The complex circumferential attachment between the zonuli and the capsular bag results in variable and unpredictable equilibrium point.
- Without adjusted mechanical interface, accurate optical performances (if at all…) are not possible.
“In the bag” mechanical interface – UBM analysis

- **No correlation** could be established between the pre-op UBM images and the measured Simulator/Capsule equilibrium point.
- With no such correlation the crucial adjustment of the AIOL with its operating mechanical interface is not possible. Consequentially, the optical performance of “in the bag” positioned AIOL is anticipated to be inaccurate and unpredictable.
On the bag” mechanical interface - Morphology

• The Anterior zonuli–capsule surface is the primary mechanical interface.

• Using round interface it transforms the anterior capsule to truncated cone with the ciliary sulcus plane being its larger base and the backwards pushed AIOL/Capsular interface being the smaller base.

• This simple geometrical transformation enables calculation of the AIOL/Capsular interface, related to the ciliary sulcus plane, from pre-op UBM images.
“On the bag” mechanical interface – UBM analysis

- **Good correlation** was established between the pre-op UBM images and the measured Simulator/Capsule equilibrium point.
- This data contributed to the development of the “NuLens formula”, enabling pre-op prediction of the AIOL/Capsule interface location from pre-op UBM images.
“In the bag” vs. “On the bag” AIOL positioning – the mechanical perspective

“On the bag” positioning enables predictable primary mechanical analysis of the AIOL/Capsule interface.

Comparative force distribution at the AIOL/Capsule interface in each positions.

“On the bag”
“In the bag” vs. “On the bag” AIOL positioning –
Long term changes

- VISSUM, Alicante Spain
- 8 primates.
- 4 eyes with “In the bag” AIOL simulator gauge.
- 4 eyes with “On the bag” AIOL simulator gauge.
- 30 months follow up.

- All “In the bag” gauges were irreversibly paralyzed by fibrosis and capsular contraction around & inside them.
- All “on the bag” gauges were compressed by the contracted capsule below them. However these gauges were not harmed by fibrosis and remain function throughout the whole study.
- Capsular fibrosis is the long-term nemesis of all AIOL’s at both positions.
- As long as capsular fibrosis is unavoidable, any AIOL must have a build-in system to deal with this phenomenon.
Utilizing basic research conclusions – the *NuLens AIOL*

- “On the bag”.
- Ciliary sulcus fixation.
- On-going pilot clinical study (average follow-up of 12M).
- The mechanical adjustment of the implanted AIOL’s with the patient's capsular interface was calculated from pre-op UBM images, using a custom developed optomechanical formula.
- Vertical Adjustment Mechanism was designed and incorporated to each AIOL enabling forward repositioning of the AIOL in case of capsular fibrosis & contraction.
Out of the current clinical study - Results sample 1 (iTrace)

**Distance Corrected** (Refraction)

V/A 20/20

**Distance Corrected – Near** (35cm, Refraction)

V/A 20/25
Out of the current clinical study - Results sample 2 (iTrace)

**Distance Corrected** (Refraction)

V/A 20/20

![Image of refraction chart showing V/A 20/20 with specific lens values]

**Distance Corrected – Near** (30cm, Refraction)

V/A 20/25

![Image of refraction chart showing V/A 20/25 with specific lens values]
The greater danger for most of us lies not in setting our aim too high and falling short...

...but in setting our aim too low and achieving our mark.

michelangelo