

Sclera Crosslinking (SXL)

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and
University of Zürich**

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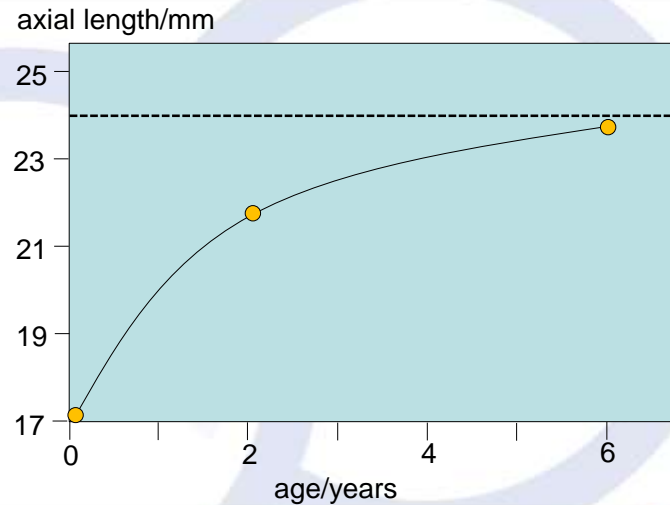
myopia

- 1. Basic science**
- 2. Myopia control**
- 3. Sclera procedures**

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basics: emmetropization

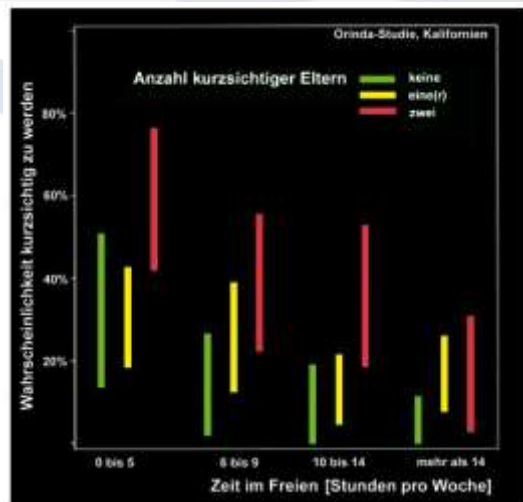


basics: emmetropization

During emmetropization the axial length of the eye is adjusted to the dioptric power of cornea and lens.

This adjustment process is influenced by peripheral vision (not foveal !) and some chemical factors, f.e. dopamin.

basics: emmetropization



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basics: emmetropization

During Emmetropization the axial length of the eye is adjusted to the dioptric power of cornea and lens.

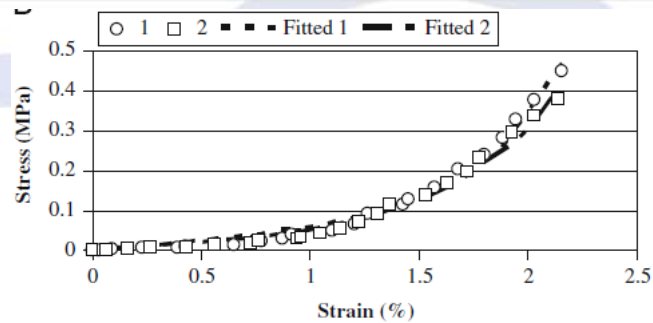
This adjustment process is influenced by peripheral vision (not foveal !) and some chemical factors, f.e. dopamin.

Muscarinic antagonists may also reduce the axial enlargement of the eye.

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basics: biomechanics sclera

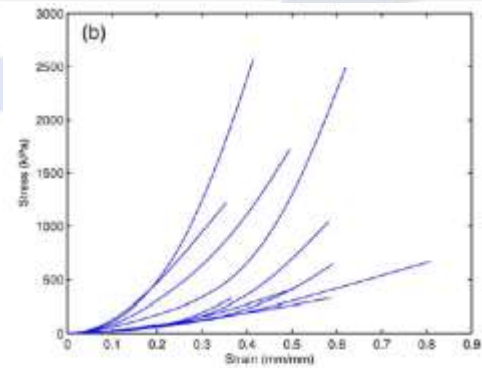


Human sclera is nonlinear elastic

A. Eilaghi et al. / Journal of Biomechanics 43 (2010) 1696–1701

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basics: biomechanics sclera



**however:
high
variability**

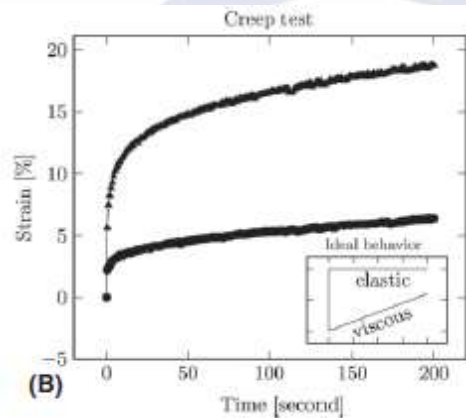
FIGURE 4. Stress-strain plots of the (a) vertical and (b) horizontal human posterior-scleral samples in the elastic region from uniaxial tests at 1 mm/s in 37°C saline ($n = 12$ for vertical and $n = 11$ for horizontal). [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

Elastic properties of human posterior eye.

Chen S¹, Bostel AP, Wetland JD, Heman M².

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basics: biomechanics sclera



Human sclera is viscoelastic

Schuldt C, et al. Acta Ophthalmologica 2014

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biomechanics sclera

Sieglwart JT, Norton TT
Regulation of the mechanical properties of tree shrew sclera by the visual environment.
Vision Res. 1999;39:387-407.

sclera creep rate

2 to 3 mm/h

**monocular form deprivation
(4 days)
with eye elongation**

**increase 200 to 300%
temporal correspondence**

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1. Basic science
2. Myopia control
3. Sclera procedures

Undercorrection of glasses and contacts:

- gold standard in the old days, today rather conversely discussed



myopia control: pharmacological

ATOM studies (Atropin for the Treatment of Myopia, Singapur)

Atropine for the Treatment of Childhood Myopia: Safety and Efficacy of 0.5%, 0.1%, and 0.01% Doses (Atropine for the Treatment of Myopia 2)

Andrey Chai, FRANZCO,^{1,2} Wei-Han Chua, FRCSEd(Ophth), FAMS,^{1,2} Yi-Bin Cheung, PhD,^{5,6} Wei-Ling Wong, MScStat,⁷ Aarsha Lingham, SRN,⁸ Allan Fong, FRCSEd(Ophth),^{1,2} Donald Tan, FRCS, FRCOphth^{1,2,3}

→ prospective, doppel-blind study in big groups. Clearly defined inclusion and success criteria

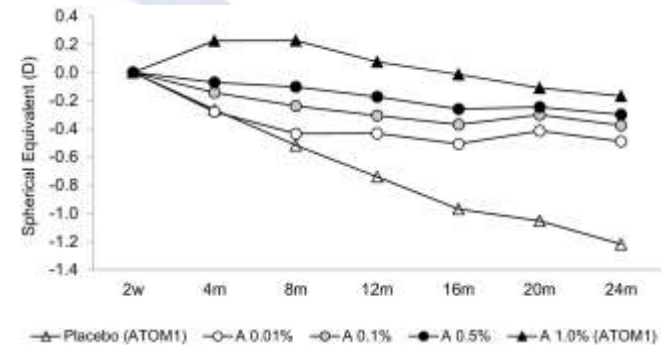
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myopia control: pharmacological

ATOM Studien (Atropin for the Treatment of Myopia, Singapur)

spherical equivalent



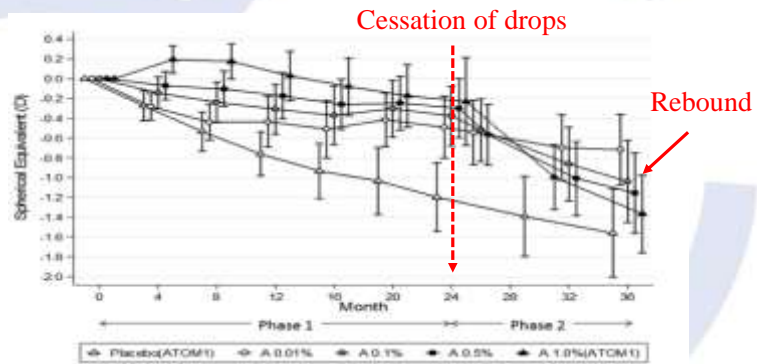
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myopia control: pharmacological

ATOM Studien (Atropin for the Treatment of Myopia, Singapur)

Aber...



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myopia

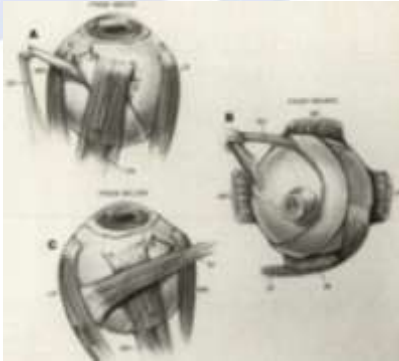
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myopia control: surgical

Historical background: Posterior scleral reinforcement



- Last negative publication in Europe
 - Chauvaud D et al., J Fr Ophtalmol, 1997
- Last negative publication in Asia
 - Li XJ et al., Int J Ophthalmol 2016

only limited success with significant side-effects

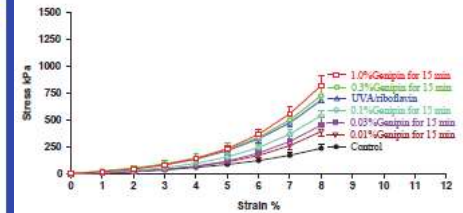
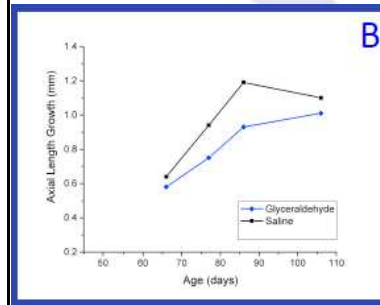
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myopia control: surgical

SXL chemical

probably effective, side effects expected but unknown



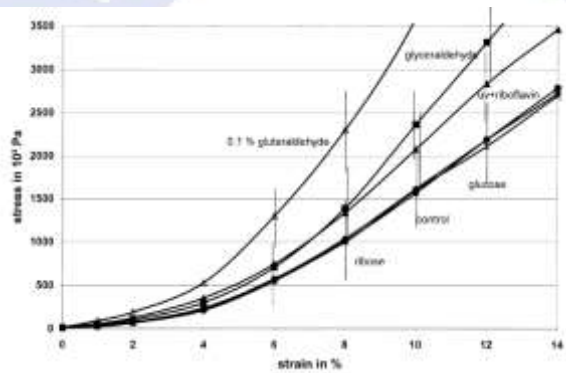
Tai-Xiang Liu, Zheng Wang
Acta Ophthalmol 2013

In Vivo Crosslinking of Scleral Collagen in the Rabbit Using
Sub-Tenon Injections of Nitroalcohol. Paik ARVO 2014

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myopia control: surgical

Scleral Crosslinking: Riboflavin + UV, immediate results



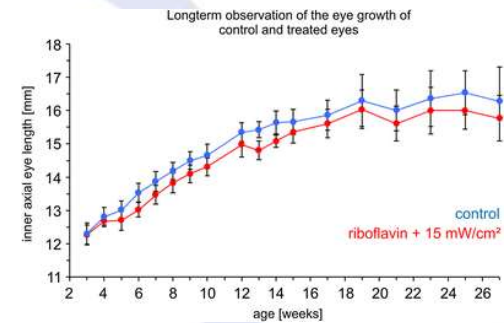
Wollensak G, Iomdina E: Long-term biomechanical properties of rabbit sclera after collagen crosslinking. Acta Ophthalmol. 2009

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myopia control: surgical

Scleral crosslinking in young rabbits with focal irradiation - elongation results:

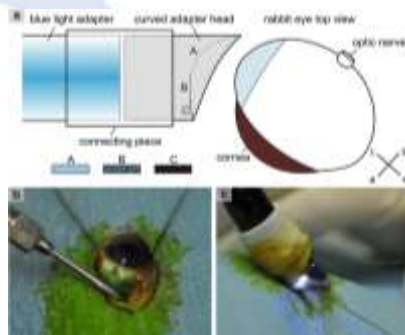


Iseli, H.P., Körber, N., Koch, C. et al.: Scleral cross-linking by riboflavin and blue light application in young rabbits: damage threshold and eye growth inhibition. Graefes Arch Clin Exp Ophthalmol (2016)

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**But.... Experimental procedures used in rabbits*
had disadvantages: focal spots, very invasive**



Iseli, H.P., Körber, N., Koch, C. et al.: Scleral cross-linking by riboflavin and blue light application in young rabbits: damage threshold and eye growth inhibition. Graefes Arch Clin Exp Ophthalmol (2016)

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myopia control: surgical

Next generation SXL: LED-belt with scattering interface

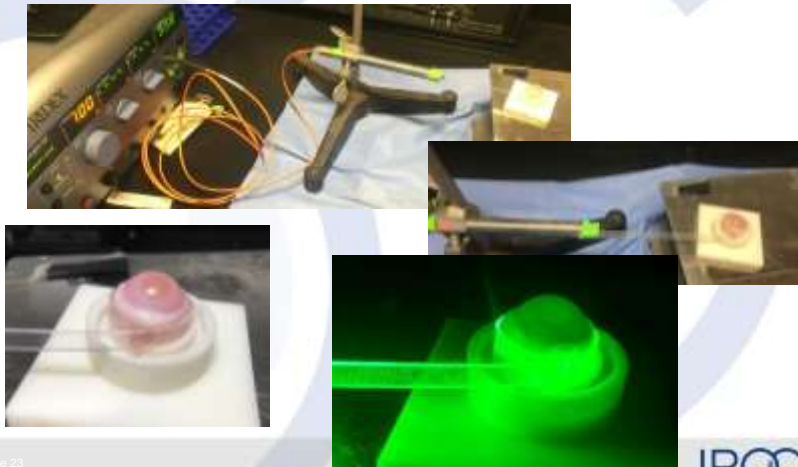


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myopia control: surgical

Next generation SXL: Laser coupled into waveguide

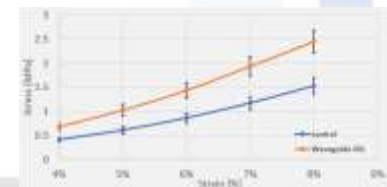
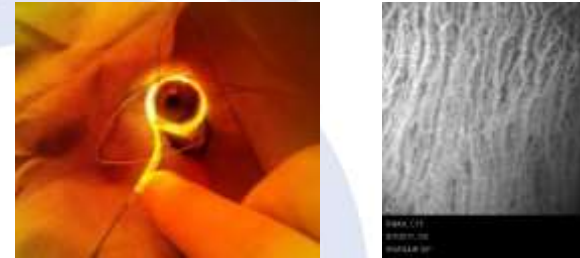


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myopia control: surgical

Next generation SXL: Laser coupled into waveguide



No surgical complications (n=12)

ICG angiography indicating safety

Extensiomtry indicating efficacy

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Take Home Messages:

1. None of the so far presented approaches of myopia control (refractive, pharmacological, surgical) is optimal.
 2. The pharmacological approach with 0.01% Atropin appears to be feasible and safe. However, expectations are higher than results.
- Scleral crosslinking has passed successfully the experimental state and clinical studies are planned

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