Corneal biomechanics
Modulating factors

Prof. Farhad Hafezi, MD PhD
Financial disclosures

• None
1. Age

- 40–59 years
- 80–99 years
1. Age
Longevity of CXL effect

1. Age

• Collagen turnover: 6-7 years

• Biomechanics increase with age

Effect of age

Stable

Effect of CXL

Collagen turnover:

6-7 years

Biomechanics increase with age

CXL EXPERTS' MEETING 2018
Longevity of CXL effect

1. Age

- Collagen turnover: 6-7 years
- Biomechanics increase with age

Effect of age

Progressive

Effect of CXL

10

20

30

40

12

22
1. Age

2. Tobacco smoking

Table 1 ORA readings: Differences in corneal biomechanical properties in non-smokers vs smokers

<table>
<thead>
<tr>
<th></th>
<th>Non-smokers (n=56)</th>
<th>Smokers (n=54)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRF</td>
<td>10.6 ± 2.0</td>
<td>11.6 ± 2.0</td>
<td>0.000013211†</td>
</tr>
<tr>
<td>CH</td>
<td>10.2 ± 2.0</td>
<td>10.7 ± 2.1</td>
<td>0.02†</td>
</tr>
</tbody>
</table>

CRF = Corneal Resistance Factor; CH = Corneal Hysteresis; Statistical analysis was performed using Student's t-test

† P<0.05

F. Hafezi, Ophthalmology, 2010
1. Age

2. Tobacco smoking

3. Pregnancy

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**Journal of Cataract & Refractive Surgery**

*Pregnancy-related exacerbation of iatrogenic keratectasia despite corneal collagen crosslinking*

Farhad Hafezi, MD, PhD, Hans Peter Iseli, MD

2008
1. Age

2. Tobacco smoking

3. Pregnancy

(Hafezi et al., JCRS 2008)
1. Age
2. Tobacco smoking
3. Pregnancy

(Hafezi et al., JCRS 2008)
1. Age
2. Tobacco smoking
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(Hafezi et al., JCRS 2008)
1. Age
2. Tobacco smoking
3. Pregnancy

Pregnancy May Trigger Late Onset of Keratectasia After LASIK

2012
To the Editor:

It is common knowledge that the biomechanical stability of connective tissue changes during pregnancy, leading to reduced stiffness and increased extensibility. These changes are most probably hormone-induced and, therefore, corneal biomechanics also may change during pregnancy.

Five patients who underwent LASIK experienced vision deterioration during pregnancy, which we attribute to iatrogenic keratectasia although the cornea prior to pregnancy was stable for years. All patients except one were primapara. All patients showed progressive keratectasia and received corneal collagen cross-linking (CXL) to stop progression.

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Age at LASIK (y)</th>
<th>Age at Onset (y)</th>
<th>Occurrence After LASIK (y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>28</td>
<td>32</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>32</td>
<td>38</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>27</td>
<td>32</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>33</td>
<td>37</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>31</td>
<td>40</td>
<td>9</td>
</tr>
</tbody>
</table>

Representative case: A 32-year-old woman underwent bilateral LASIK in Turkey for -11002 5.00 diopters in the right eye and -11002 4.50 D in the left eye in 2002. Preoperative topography is shown in the Figure. According to the patient, the surgeon stated that uncorrected distance visual acuity (UDVA) was 20/20 in both eyes at 6-month follow-up. Postoperative UDVA remained stable for 6 years until her seventh month of pregnancy in July 2008. Scheimpflug analysis showed keratectasia in the right eye with Kmax values of 51.60 D and a minimal corneal thickness of 359 µm, compared to 45.30 D and 398 µm and a normal topography in the left eye.

Our results suggest that, aside from misinterpretation of preoperative topography and low residual stromal thickness, additional factors may induce iatrogenic keratectasia under certain circumstances. We cannot rule out that some of the cases could have had a preexisting minimal corneal thickness at the lower end of the normal distribution (ie, 505 µm), a minor asymmetry and elevation at the posterior pole (ie, 12 µm at a reference sphere of 8 mm), or even keratoconus. These corneas might have been borderline compensated and biomechanically stable until an additional factor arose, eg, the increase in serum estrogen levels during pregnancy. This may explain why ectasia occurred up to 9 years after LASIK concomitant with pregnancy.

Only a few cases of iatrogenic keratectasia and keratoconus occurring during pregnancy have been reported, with one included in this series. There is growing evidence that the massive estrogen increase in late pregnancy not only prepares the female body for birth but may also increase the risk of keratectasia in predisposed individuals. Suzuki et al identified estrogen receptors in the human cornea, and Spoerl et al have shown that ex vivo porcine corneas show a distinct reduction in biomechanical stiffness when exposed to...
1. Age

2. Tobacco smoking

3. Pregnancy
Transitory Topographical Variations in Keratoconus During Pregnancy

Hoogewoud and Hafezi, 2013

2013
1. Age
2. Tobacco smoking
3. Pregnancy

Pregnancy I, week 4

CDVA 1.0

CDVA 1.0
1. Age
2. Tobacco smoking
3. Pregnancy

Pregnancy I, week 20

CDVA 0.7

CDVA 0.9
Pregnancy I, 24 weeks after delivery

CDVA 0.7

CDVA 1.0
Pregnancy II, week 16

CDVA 0.6

CDVA 1.0
1. Age

2. Tobacco smoking

3. Pregnancy

4. Thyroid

- Keratoconus patients: symptoms of hypothyroidism
- Keratoconus after thyroidectomy

(Appelbaum, 1936, Surv Ophthalmol)
(King, 1953, Trans Ophthalmol Soc UK)
(Kocak et al, 1999, Eur J Ophthalmol)
1. Age
2. Tobacco smoking
3. Pregnancy
4. Thyroid
1. Age

2. Tobacco smoking

3. Pregnancy

4. Thyroid

Pregnancy-induced Changes in Corneal Biomechanics and Topography Are Thyroid Hormone Related

DAVID TARRIAN, BEGOÑA M. DE TEJADA, ZISIS GAZZIOUFAS, SABINE KLING, VANESSA S. MEISS, MARG-OLIVIER BOLDI, VÉRONIQUE OTHENIN-GIRARD, ANTONINA CHILIN, JULIEN LAMBIEL, FLORENCE HOOGEWoud, AND FARHAD HAFEZI
Thyroid and KC

1. Keratoconus
2. Cross-Linking
3. Screen & Treat
4. Estrogen
5. Thyroid

- 53 year-old female with Graves’ disease
- Visual acuity 20/20
- Radioactive iodine therapy
- One year later: KC Grade II-III with Kmax > 50D

Bilateral Keratoconus Induced by Secondary Hypothyroidism After Radioactive Iodine Therapy

Ramon Lee, MD; Farhad Hafezi, MD, PhD; J. Bradley Randleman, MD

JRS, 2018
1. Age
2. Tobacco smoking
3. Pregnancy
4. Thyroid
5. Down Syndrome

2-8%
• Several factors can modulate corneal biomechanics and shape

• These factors must be considered when planning refractive procedures