What should I know about optics and physiological optics when I fit contact lenses?

The position of the contact lens is different in relation to the eye. This is obviously the first criterion to take into consideration.

According to the power of the spectacles, the difference $\Delta$ between the power of spectacle lenses and the contact lenses will be more or less important.
Variation of powers between the two systems (contact lenses and spectacle)

<table>
<thead>
<tr>
<th>Distance (mm)</th>
<th>D_L</th>
<th>-20</th>
<th>-15</th>
<th>-10</th>
<th>-8</th>
<th>-5</th>
<th>+4</th>
<th>+10</th>
</tr>
</thead>
<tbody>
<tr>
<td>D_CL</td>
<td>16.13</td>
<td>12.73</td>
<td>9.35</td>
<td>7.20</td>
<td>4.12</td>
<td>1.20</td>
<td>11.46</td>
<td></td>
</tr>
<tr>
<td>D_CL</td>
<td>15.38</td>
<td>12.24</td>
<td>9.70</td>
<td>7.14</td>
<td>4.65</td>
<td>1.26</td>
<td>11.76</td>
<td></td>
</tr>
<tr>
<td>Δ</td>
<td>3.87</td>
<td>2.29</td>
<td>1.07</td>
<td>0.70</td>
<td>0.28</td>
<td>0.20</td>
<td>1.36</td>
<td></td>
</tr>
<tr>
<td>σ=10 mm</td>
<td>4.62</td>
<td>2.76</td>
<td>1.30</td>
<td>0.86</td>
<td>0.35</td>
<td>0.26</td>
<td>1.76</td>
<td></td>
</tr>
</tbody>
</table>

Magnification

- The distance eye-spectacles versus eye contact lens being different, the magnification of the retinal image will be different.
- This in turn will induce changes in the visual acuity.
- The relationship is linear.

Visual acuity

- The myop will have a higher visual acuity with contact lenses, while the hyperop will have to accept a moderate loss in visual acuity.
Variation in % of the retinal image size as a function of the power of the glasses

Visual acuity

<table>
<thead>
<tr>
<th>Spectacle power</th>
<th>-20</th>
<th>-15</th>
<th>-10</th>
<th>-5</th>
<th>+5</th>
<th>+10</th>
<th>+15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retinal image ratio</td>
<td>1.24</td>
<td>1.18</td>
<td>1.12</td>
<td>1.06</td>
<td>0.94</td>
<td>0.88</td>
<td>0.82</td>
</tr>
<tr>
<td>VA Glasses</td>
<td>10/10</td>
<td>10/10</td>
<td>10/10</td>
<td>10/10</td>
<td>10/10</td>
<td>10/10</td>
<td>10/10</td>
</tr>
<tr>
<td>VA Contact lens</td>
<td>12.4/10</td>
<td>11.8/10</td>
<td>11.2/10</td>
<td>10.6/10</td>
<td>9.4/10</td>
<td>8.8/10</td>
<td>8.2/10</td>
</tr>
</tbody>
</table>

Visual field

- With spectacles:
  - The hyperope has a zone where he does not see (annular scotoma)
  - The myope has a zone of double vision in his field of vision
- With contacts: none of the above occurs.
Accommodation and Contact Lens

- Because of the distance eye-lens, the accommodative requirement changes between contact lenses and glasses.
- A myop may have difficulty for near as the accommodative requirement will be more with contact lenses. This may give a problem in patients in their forties. They will require near vision correction much earlier with contacts than with glasses.
- For hyperops, there will be a reduced accommodative requirement. This may become interesting in patients in their forties as it may allow to read better and prolong the time without near vision glasses.
Flux of oxygen – Dk - Dk/t

<table>
<thead>
<tr>
<th></th>
<th>Volume of oxygen through a specific zone of the lens per a specific time</th>
<th>μlO₂(cm²sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen flux J</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxygen permeability Dk</td>
<td>Quantity of oxygen through the material of the lens for a specific time and a given pressure difference</td>
<td>10⁻⁹ (cm³O₂/(cm²mmHg sec))</td>
</tr>
<tr>
<td>Oxygen transmissibility Dk/t</td>
<td>Quantity of oxygen through a lens of a specific thickness in a specific time and with a given pressure difference</td>
<td>10⁻⁹ (cm³ ml O₂/(ml sec mmHg))</td>
</tr>
</tbody>
</table>

Materials

Overview :

Hard = PMMA
Flexible = CAB, Si-Fl-MMA
Soft = Hydrogel, Si-Hydrogel

Materials

Flexible = Si-Fl-MMA
Silicon-Fluor-Methylen-Methacrylat since 1970’s Dk 12 - 200

- All diameters between 8.8 to 11.5 mm.
- All powers.
- Multi- or aspheric curve design.
- Daily and extended wear (DW / EW) 12 - 24 hours/day.
- Exchange every 2 - 3 years.
- More difficult to clean, protein and lipid deposits.
Materials

Soft = Hydrogel
Poly-Hydroxy-Ethylene-Methacrylat (+) since 1963
(water content 38% - 86%, Dk 8 - 45)

- All diameters between 12.0 to 18.0 mm.
- All powers.
- Single, multi- or aspheric curve designs.
- Daily (DW) 6 - 12 hours/day.
- Exchange daily to 2 years.
- Disposable and conventional
- More protein deposits
- Limbal redness

Materials

Soft = Silicone-Hydrogel
Silicon-Poly-Hydroxy-Ethylene-Methacrylat since 1999
(water content 24% - 50%, Dk 55 - 175)

- All diameters between 12.0 to 18.0 mm.
- All powers.
- Single, multi- or aspheric curve designs.
- Daily and extended wear (DW/EW) 12 - 24 hours/day.
- Exchange weekly to 2 years.
- Disposable and conventional
- More lipid deposits
- Excellent therapeutic use
- "White eyes"
Obituary - Rigid contact lenses

- The author does not believe in rigid contact lenses
- However, there are still some indications where rigid contact lenses with high Dk are necessary:
  - **Pediatric (Babies, toddlers, children under 6)**
  - Pediatric age 6 to 12 (because they are safer than Silicone-Hydrogel ones)
  - Permanent wear (of course, also Silicone-Hydrogel lenses)
  - Presbyopia (Optics is far better than in soft lenses)
  - **Keratoconus**
  - **Orthokeratology.**

Wearing Modality

**Disposable system:**
- One-Day
- 1 – 4 weeks

**Conventional system:**
- Several months to several years

Wearing Modality

**Daily wear**
- vs.
**extended wear**
- vs.
**constant wear?**
Wearing Modality

Daily wear:
From a few hours per month up to 12 hours per day
- One-Day lenses (soft CL)
- low Dk 8 - 45 (flexible and soft CL)

Extended wear:
From 12 hours up to 16 hours per day
Middle - high Dk 50 – 86 (flexible, and Si-Hydrogel CL)

Permanent wear:
From 18 hours per day up to 24 hours per day
Extreme high Dk 87 – 175 (flexible and Si-Hydrogel CL)
Oxygen transmissibility and flux

<table>
<thead>
<tr>
<th>Lens Description</th>
<th>Dk/L</th>
<th>Flux O2 (%) Open Eye</th>
<th>% of maximum</th>
<th>Flux O2 (%) Closed Eye</th>
<th>% of maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hema</td>
<td>7.5</td>
<td>5.95</td>
<td>52</td>
<td>3.10</td>
<td>28</td>
</tr>
<tr>
<td>Acuvue 2</td>
<td>26</td>
<td>6.65</td>
<td>88</td>
<td>4.09</td>
<td>68</td>
</tr>
<tr>
<td>Acuvue Advance</td>
<td>86</td>
<td>7.31</td>
<td>97</td>
<td>5.55</td>
<td>92</td>
</tr>
<tr>
<td>PureVision</td>
<td>110</td>
<td>7.37</td>
<td>98</td>
<td>5.68</td>
<td>94</td>
</tr>
<tr>
<td>Night &amp; Day</td>
<td>175</td>
<td>7.44</td>
<td>99</td>
<td>5.84</td>
<td>97</td>
</tr>
<tr>
<td>Without lens</td>
<td>7.54</td>
<td>100</td>
<td>100</td>
<td>6.04</td>
<td>100</td>
</tr>
</tbody>
</table>

Water content in silicone-hydrogel lenses of the 2nd and 3rd generation (from Menicon)

Different surface treatment

The Purevision: plasma oxidation of the silicones into silicates. The hydrophilic silicate covers the hydrophobic silicone.

The Night & Day: modification at the surface by a plasma treatment which transforms the material into a hydrophilic polymer of 25 nanometers.

O2Optix has the same surface treatment as the N&D.

Acuvue Advance: no treatment because of the hydralc radical fixing water on the surface.

Premio has a surface treatment.

Biofinity has no surface treatment.
Surface treatment

- **Lotrafilcon A**
  - Chemical uniform highly refractive coating
  - Resistance to bacterial adhesions
  - Groupe I de la FDA (non ionic, low H2O)

- **Balafilcon A**
  - Treatment by oxidation and non polymerisation
  - Silicate zones may appear
  - Groupe III de la FDA (ionic, low H2O)

---

Bausch & Lomb Vision Care, Vol. 4, January 2006

<table>
<thead>
<tr>
<th>Surface</th>
<th>RMS Roughness (in nanometers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PureVision</td>
<td>6nm +/- 3 nm</td>
</tr>
<tr>
<td>O2 Optix</td>
<td>7nm +/- 3 nm</td>
</tr>
<tr>
<td>Night &amp; Day</td>
<td>6 nm +/- 3 nm</td>
</tr>
<tr>
<td>ACUVUE Advance</td>
<td>4 nm +/- 1</td>
</tr>
</tbody>
</table>

---

Hygiene and lens care
Why do we have to use products to take care of our lenses?

- Biocompatibility, cleanliness, wettability and transparency are necessary for a good tolerance of the contact lenses.
- The lacrimal fluids in which lenses are soaked produce deposits and manipulations are causes of contamination.
- Smears and germs interact favoring each other:
  - Deposits are an ideal nutritional substrate for germs
  - Germs secrete a biofilm which is adherent to the lens surface.

Common properties of the care solutions which have to enter in contact with the eye surface

- Non toxic: a toxic care solution must be neutralized
- Sterile: after opening of the container, the prevention of contamination is obtained either by adding a conservative agent or using a unidose system (rinsing solutions) or an aerosol (rinsing solutions)
- Isotonic
- Buffered at a neutral pH

Three options are available for the contact lens specialist

- Daily disposable
- Multiple use with a lens care system chosen in agreement with the renewal rate and type of the lens. The choice must be understood by the patient, as its observance will determine the safety of wear.
- Permanent wear
Purpose of the lens care

- Prevent or eliminate the deposits by a cleaning
- Eliminate the germs by decontamination

Etiology and consequences of the deposits on the contact lens

- The deposits come mainly from the ocular media
  - mostly from the tears
- The environment
  - Pollution
  - Cosmetics
  - Eye drops …

The rate of formation of deposits varies greatly from one patient to the other

- Quality of tears, ocular dryness...
- Lenses: age, type of material – soft or rigid, ionic or non-ionic, hydrophilicity ...
- Environment: air condition, pollution, usage of cosmetics

One has to take these factors into consideration when choosing the lens care system and the frequency of renewal of the lens
Contamination of the lenses

The infections can be of following origin:
- Bacterial
- Fungal
- Viral
- Amoeba
- Non conventional transmissible agents (NCTA)

Bacterial contamination (1)

- Studies show that there is an inversion of bacterial flora in the majority of contact lens wearers. The flora consists of a majority of gram negative - 73% versus 35%.
- External sources are more frequently responsible for the contamination - manipulation, case, etc. - than the lacrimal film.
- The lacrimal film is an excellent media for the growth of germs because of its neutral and stable pH, its temperature and the proteins it contains.

Bacterial contamination (2)

- The deposits on the lens diminish the repulsion forces of the material – electric charge – allowing the bacteria to adhere.
- The microorganisms dig themselves. They are able to adhere to the lenses because they produce polysaccharides, which in turn protect them from ocular defenses.
- Gram negative bacteria are more often the cause of corneal ulcers in contact lens wearers.
- The size of the bacteria is too large to penetrate in the material of the soft lenses.
Fungal contamination
- Fungi can adhere to the surface of a relatively clean contact lens and penetrate into the matrix of the soft lens. They are not normally present in the lacrimal flora.
- The fungi are Aspergillus, Fusarium and Candida. Sources of contamination are external (cosmetics, plants).
- Corneal lesions are a favoring factor.

Viral contamination
- Viruses are the most feared infectious agents in a practice (Keratoconjunctivitis, herpes...).
- Viral hepatitis B DNA can be recovered from the tears of 40% of the affected patients.
- Viral hepatitis C DNA can be found in 100% of the infected patients.
- The possibility to acquire hepatitis C through the conjunctival mucosa is confirmed.
- The Human Immunodeficiency Virus (HIV) has been isolated from tears of sero-positive contact lens wearers after 14-16 hours of wear but a transmission is highly improbable because of the very low concentration of the infected material.

Amoebaean contamination
- Amoebas are unicellular organisms living in water – rivers, lakes, swimming pools, tap-water…
- Their size - 15 to 45 μm for the trophozoite et 16x7 μm for the cyst – makes it impossible to enter the matrix of soft contact lenses.
- The spoilage of a contact lens with contaminated water may induce a contaminations of the lens.
- The most frequent observed amoeba is Acanthamoeba.
Prion

- At least 3 cases of transmission of Creuzfeldt-Jacob by corneal graft are on record.
- The risk of transmission of the disease by a contact lens is unknown but can not be excluded. The trial lenses which may be used for several patients come under the European regulation 138 from March 2001.
- A questionnaire is mandatory to precise the risk in each patient.

Oxidative decontaminants (1)

- They are extremely active if the time of contact is sufficient.
- They are very toxic and require a full neutralization before replacing the lens on the eye.
- The most widely used is the Hydrogen peroxide (H₂O₂). The neutralization requires the presence of a catalyzer:
  - Platinum disk
  - Catalase - either a tablet added to the oxidative solution or diluted in a 2nd solution called neutralizing solution.

Oxidative decontaminants (2)

- It can be presented without conservation agent.
- After neutralization, it is transformed into water.
- Sodium-hypochlorite is used for rigid lenses. It is very active against prions and plays an active role against protein deposits.
Temperature

- Very effective, but modern soft lenses do not tolerate heat

Deproteinization (1)

- They prevent or eliminate protein deposits strongly attached to the soft and/or hard lenses
- Their action can be active or passive
- While it is not necessary to deproteinize frequent replacement soft lenses, it is strongly recommended to do so for conventional soft lenses or for rigid gas permeable

Deproteinization (2)

- The enzymes (active deproteinization): 
  - Papain comes from plants (tablets)
  - Pancreatin is of animal origin and is active against proteins, lipids, polysaccharides, glycoproteins and mucus (tablets or solution)
  - Subtilisin A & B: bacterial origin active against proteins (tablets to dissolve)
Deproteination (3)

- Passive deproteination: by chelating calcium ions:
  - Hydranate
  - Ionic shifting: citrate
  - Creating a film: HMPC

- Oxidants: certain oxidants do have deproteination action:
  - Mechanical action of the oxygen bubbles during neutralization
  - Efficacy of the sodium-hyper chloride or the sodium-hypobromite (PROGENT)

Multifunction solutions

- Surfactant or citrate
- Decontaminant: usually polymeric
- EDTA (prevents the deposition of calcium and increases the action of the decontaminant)
- Osmolarity agent
- Buffer
Oxidative system

- A solution $\text{H}_2\text{O}_2$ 3%
- 1 step: neutralization by a disc of platinum or a tablet of catalase. Advantage: simplicity
  Inconvenience: the concentration drops immediately, long procedure
- 2 steps: neutralization by a liquid catalase
  Advantage: speed

For permanent wear

- No up-keep necessary
- However, the patient must have a case and a product at hand if for any reason he has to take the lens out
- One has to prescribe him lubricating drops

Fitting procedure

Flexible contact lens:
1. BC according the real cornea radii.
2. Diameter smaller for tear exchange or larger for quicker adaptation and less dust problems.
3. Power according calculation formula.
4. Slit lamp check after insertion for position and movement.
5. Fluorescein check for adequate design (BC and asphericity).
6. Introduction about lens care system and wearing modality during adaptation phase.
7. Schedule for next visit in 1 week, 1 month, 3-6 months.
Fitting procedure

Soft and Silicone-Hydrogel contact lens:
1. BC according the real cornea radii PLUS 0.4 to 1.2 mm depending the chosen material.
2. Diameter app. 1 mm larger than the visible corneal diameter.
3. Power according calculation formula.
4. Slit lamp check after insertion for position and movement.
5. Introduction about lens care system and wearing modality during adaptation phase.
6. Schedule for next visit in 1 week, 1 month, 3-6 months.

Suggestions for a beginner’s choice

- One-Day Acuvue Moist (8.5/9.0) or Dailies AquaComfortPlus
- Acuvue Oasys (8.4/8.8) or Night & Day (8.4/8.6)
- Menicon-Z for hard lenses

Patient Compliance
162 patients were evaluated after their routine examination.

- 14% identified themselves as non-compliant.
- Only one third of the patients who perceived themselves as compliant exhibited a good level of compliance.
- 80% were aware of risk factors.
- Replacing the lens case was the only behavior associated with a positive history of having experienced a prior contact lens-related complication ($P=0.002$).

### Patient awareness vs. Doctors opinion

<table>
<thead>
<tr>
<th></th>
<th>Patient awareness</th>
<th>Doctors opinion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compliant</td>
<td>86%</td>
<td>32%</td>
</tr>
<tr>
<td>Average compliance</td>
<td></td>
<td>44%</td>
</tr>
<tr>
<td>Non-compliant</td>
<td>14%</td>
<td>24%</td>
</tr>
</tbody>
</table>

**From no rub - no rinse to rub and rinse**

The return of the old routine
A comparison of regimen methods for the removal and inactivation of bacteria, fungi and Acanthamoeba from two types of silicone hydrogels
Contact Lens and Anterior Eye 2009, 32: 73-77

- Four multipurpose solutions were examined representing manufacturer recommended regimens of “rub & rinse”, “no rub, rinse” and “no rub, no rinse”.
- Test organism were Pseudomonas aeroginosa, Serratia marcescens, Staphylococcus aurous, Fusarium solani, Candida albicans and Acanthamoeba castellani (trophozoites and cysts).
- Acuvue Oaysis and Air Optix

The findings of this study demonstrate that the use of a manual rubbing step is more effective than rinsing or soaking alone in removing pathogenic microbes from silicone hydrogel lenses.

Accordingly, it would seem wise to recommend that contact lens care systems include a rub step as part of the hygiene.

By this criterion, only Complete Easy Rub gave satisfactory results for all bacteria (study sponsored by AMO).

Impact of a rinse step on protein removal from silicone hydrogel contact lenses
Optometry & Vis. Sci. 2009, 86: 943-947

- Twenty contact lens wearers using a multipurpose solution
- Rinsing a contact lens after removal from the eye removes well more than one-half of the protein associated with it.
Status of the effectiveness of contact lens solutions against keratitis-causing pathogens.
Siddiqui R. et al., Contact Lens and Ant. Eye 2015, 38: 34-38

- ReNu Multiplus, Dura Plus and Optifree Express killed *P. aeruginosa*, *S. marescens*, *S. aureus* and MRS when tested with the manufacturer’s recommended disinfection time.
- Locally formulated solutions did not exhibit any bactericidal activity.

Comparison of surface roughness and bacterial adhesion between cosmetic contact lenses and conventional contact lenses.
Ji Y.W. et al. Eye and Contact Lens 2015, 41: 25-33

- Increased surface roughness is an important physical factor for bacterial adhesion in cosmetic contact lenses which may explain why rates of bacterial keratitis are higher in cosmetic contact lens wearers.

<table>
<thead>
<tr>
<th></th>
<th>Conventional</th>
<th>Cosmetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convex surface roughness Daily wear</td>
<td>9.08</td>
<td>34.03</td>
</tr>
<tr>
<td>Extended wear</td>
<td>10.89</td>
<td>51.69</td>
</tr>
<tr>
<td>Continuous wear</td>
<td>19.87</td>
<td>27.97</td>
</tr>
<tr>
<td>Convex surface roughness Daily wear</td>
<td>9.96</td>
<td>32.71</td>
</tr>
<tr>
<td>Extended wear</td>
<td>19.88</td>
<td>32.71</td>
</tr>
<tr>
<td>Continuous wear</td>
<td>21.90</td>
<td>54.95</td>
</tr>
</tbody>
</table>
Trouble-shooting

What is your choice?

Wu Y, Carnt N, Stapleton F. Contact lens profile, attitudes and level of compliance. Contact lens & Ant. Eye 2010, 33: 183-188
Compliant patients had better subjective comfort and vision at the end of the day and when needed replacement, regardless of replacement modality.

Optimal subjective performance with SH lenses seems to be facilitated by replacing lenses as recommended.

Non compliant = > 17 D for two weeks replacement and > 31 D for monthly

What about extended wear?

There are still indications
High Hyperopia

No ways to handle the lenses!

High hyperopia and presbyopia
(+8.00 & +6.00 Oasys R_8.8)
Child age 6 with + 14.00 o.u. with permanent wear lenses Saphir +17.50 o.u.


<table>
<thead>
<tr>
<th>Australia</th>
<th>Percentage</th>
<th>Type of lenses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep with their lenses</td>
<td>31%</td>
<td>39% monthly All on Silicone Hydrogel lenses</td>
</tr>
<tr>
<td>Occasional overnight wear</td>
<td>19%</td>
<td>Only 27% on Silicone Hydrogels</td>
</tr>
</tbody>
</table>

The Silicone-Hydrogels
The best for post-refractive surgery?
Daily disposable contact lenses

Crossover evaluation of silicone hydrogel daily disposable contact lenses

<table>
<thead>
<tr>
<th>Contact Lens</th>
<th>Dailies Total 1</th>
<th>TrueEye</th>
<th>Clariti</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>Delfilcon A</td>
<td>Nanofilcon A</td>
<td>Telcon I 3</td>
</tr>
<tr>
<td>Water content</td>
<td>33% (80% surface)</td>
<td>46</td>
<td>56</td>
</tr>
<tr>
<td>Base curve</td>
<td>8.5</td>
<td>8.5</td>
<td>8.6</td>
</tr>
<tr>
<td>Diameter</td>
<td>14.1</td>
<td>14.2</td>
<td>14.1</td>
</tr>
<tr>
<td>O2 transmissibility</td>
<td>156</td>
<td>118</td>
<td>86</td>
</tr>
<tr>
<td>Modulus</td>
<td>0.7</td>
<td>0.7</td>
<td>0.5</td>
</tr>
</tbody>
</table>

- Over 16 hours wear-time
- Dailies Total 1 retains an unbroken tear layer for a longer period than One-day Acucue TrueEye and Clariti 1-day
Never use contact lenses in dry eye patients
Is this still true?

Chalmers R et al.
Improving contact-lens related dryness symptoms with silicone hydrogel lenses.

- Prevalence of frequent dryness symptoms was compared between hydrogel contact lens wear and non wearers. 47% fewer non-wearers reported frequent dryness than contact lens wearers.
- Patients were refitted with silicone hydrogels (Lotrafilcon A or B).
- In the Lotrafilcon A daily wear refitting trial, frequent dryness was reported by 62% fewer subjects during the day and at the end of the day.
- In continuous wear, Lotrafilcon A trials, 41% reduction.
- In conclusion, after refitting, the proportion of symptomatic wearers was approximately half.

Risk factors
What to watch?
### Comparison Hydrogel/Silicone Hydrogel risk of microbial keratitis per 10,000 wearers

<table>
<thead>
<tr>
<th></th>
<th>Dw</th>
<th>Ew</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogel lenses</td>
<td>4.1</td>
<td>20.9</td>
</tr>
<tr>
<td>(USA)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrogel lenses</td>
<td>2.16</td>
<td>10.0</td>
</tr>
<tr>
<td>(Switzerland)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrogel lenses</td>
<td>3.5</td>
<td>20.0</td>
</tr>
<tr>
<td>(Netherlands)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silicone Hydrogel</td>
<td>3.5</td>
<td>18.0</td>
</tr>
<tr>
<td>lenses (England)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Increased risk for contact lens wear

*From L. B. Szcotka-Flynn, CLAO International Contact Lens Summit, Montreal, 2009*

<table>
<thead>
<tr>
<th></th>
<th>Stapleton Australia</th>
<th>Dart Moorfields</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occasional overnight wear</td>
<td>3.9</td>
<td>1.87</td>
</tr>
<tr>
<td>Regular overnight wear</td>
<td></td>
<td>5.28</td>
</tr>
<tr>
<td>Poor storage case daily care</td>
<td>3.7</td>
<td></td>
</tr>
<tr>
<td>Smocking daily</td>
<td>2.96</td>
<td></td>
</tr>
</tbody>
</table>

### Increased risk for contact lens wear

*From L. B. Szcotka-Flynn, CLAO International Contact Lens Summit, Montreal, 2009*

<table>
<thead>
<tr>
<th></th>
<th>Stapleton Australia</th>
<th>Dart Moorfields</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase on Internet 2 days per week</td>
<td>4.76</td>
<td>3.46</td>
</tr>
<tr>
<td>Less or 6 months wear</td>
<td>4.42</td>
<td></td>
</tr>
<tr>
<td>High socio-economic daily</td>
<td>2.66 (daily)</td>
<td>2.76 (extended)</td>
</tr>
</tbody>
</table>
Increased risk for contact lens wear

<table>
<thead>
<tr>
<th>Stapleton Australia</th>
<th>Dart Moorfields</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyperopia</td>
<td>1.77</td>
</tr>
<tr>
<td>More than 50 years of age</td>
<td>0.45 protection</td>
</tr>
<tr>
<td>Male</td>
<td>1.48</td>
</tr>
</tbody>
</table>

From L. B. Szcotka-Flynn, CLAO International Contact Lens Summit, Montreal, 2009

Altered patterns of fungal keratitis at a London referral hospital: an eight-year retrospective study.


- 70% filamentary fungal infection
- 25% yeast infections
- 5% mixed
- Risk: Contact Lens 57%
  - Ocular surface disease 22%
  - Ocular surgery 22%
  - Trauma 12%
  - Prior steroid use 32%

Seasonal variation in the presentation of infectious keratitis

Gorski et al. Eye and Contact Lens, 2016, 42:295-297

- The summer months have a higher frequency of infectious keratitis and Pseudomonas aeruginosa positivity (48% of cases)
- From the 60 patients with contact-lens related infectious keratitis 50% were in summer.
- From the positive culture, 50% were contact lens wearers.

- Patients with history of herpes simplex virus keratitis have a median recurrence rate of 0.4 episodes per year in comparison to 0.2 for non-contact lens wearers (p =0.02).
- Retrospective study.

Effects of smoking on corneal thickness and the corneal endothelial cell layer in otherwise healthy subjects Ilhan et al. *Eye and Contact lens* 2016, 42: 303-307

- No effect on cell polymorphism and poymegathism
- Reduces endothelial cell count.


- Poor general health
- Respiratory diseases
- Thyroid disease
- Recommend flexibility in wear schedule
- Selection of a lower risk wear schedule
Pseudo-ptosis with moderately tolerated hard lenses

Gigant Papillary Conjunctivitis GPC

GPC-scaring
Conjunctival hyperemia

Neovascularisation

Corneal infiltrate risks
Contact Lens-related Cies (B&L)
- Permanent wear
  - 2x-5x
- MPS
  - 3x
- SiHy material
  - 2x

Protection
- Daily disposable lenses
  - 2x
- Mucin balls
  - 6x
Corneal erosions (1)

Corneal erosions (2)

Upper and inferior arcuate staining
SEAL (Superior Epithelial Arcuate stain)
There is an alarming increase in Myopia in the world. The experimental work on monkeys demonstrates that peripheral hyperopic defocus alters refractive development. Clinical trial with special lenses correcting this phenomenon seems to be promising. Trials with orthokeratology is also promising because it would produces a similar in-focus peripheral image.

1Fonn D. Myopia control and new editorial Board Eye & Contact Lens, 2010, 36: 189
2Smith E, Hung LF, Huang G. Relative peripheral hyperopic defocus alters central vitreous development in infant monkeys, Vision Res. 2006, 46: 2386-2392
Myopia Control & Contact Lens

- At 12 months, there were no statistically significant differences in the rate of progression of myopia between the control and the novel lens wearing eyes for the age group 6 to 16 years.


Summary of the studies on Orthokeratology for the reduction of myopia

<table>
<thead>
<tr>
<th>Study</th>
<th>Duration (years)</th>
<th>Distribution</th>
<th>Type</th>
<th>Numbers</th>
<th>Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cho et al. 2005</td>
<td>2</td>
<td>Retro-spective</td>
<td>Glasses</td>
<td>35/35</td>
<td>46%</td>
</tr>
<tr>
<td>Walline et al. 2009</td>
<td>2</td>
<td>Retro-spective</td>
<td>Soft Lenses</td>
<td>28/28</td>
<td>36%</td>
</tr>
<tr>
<td>Kakita et al. 2011</td>
<td>5</td>
<td>Choice</td>
<td>Glasses</td>
<td>42/50</td>
<td>36%</td>
</tr>
<tr>
<td>Santodomingo-Rubido et al. 2012</td>
<td>2</td>
<td>Choice</td>
<td>Glasses</td>
<td>22/21</td>
<td>30%</td>
</tr>
<tr>
<td>Cho and Cheung 2012</td>
<td>2</td>
<td>Choice</td>
<td>Glasses</td>
<td>31/30</td>
<td>32%</td>
</tr>
<tr>
<td>Hiraoka et al. 2012</td>
<td>2</td>
<td>Random</td>
<td>Glasses</td>
<td>37/41</td>
<td>43%</td>
</tr>
</tbody>
</table>

The risk of microbial keratitis with overnight corneal reshaping lenses

Bullimore MA, Sinnott LT, Jones-Jordan LA. Optometry & Vis. Sci 2013, 90: 937-944

- Sample of 1317 patients (640 adults and 677 children)
- Representing 2599 patients-years of wear
- 8 corneal infiltrates (6 in children & 2 in adults)
- Incidence of MK 7.7 per 10 000 years of wear
- Higher in children 13.9 per 10 000
Deposits on the lens

Proteins
- Semi-opaque or translucent film
- Denaturation of proteins by heat

Lipids
- Fatty and brilliant appearance
Biofilms

- Biofilms involve the contamination of surfaces and the formation of colonies of organisms sequestered in a glycocalyx where they become symbiotic and live in this encapsulated environment.
- The natural defense mechanisms in the eye maintain the contamination of contact lenses at very low levels (in the order of 20–30 per lens). But, patients add 2000 to 10000 organisms to the lenses when they handle and start the care product. Then the patient recontaminates their lenses when they reinsert them, in most cases the eye manages the insult.
- The problem is when the patients remove the lenses from the case, they not only contaminate the lens but also the case. This can lead to the formation of biofilms.
- Two products had to be recalled for this and there has been a serious outbreak of acanthamoeba keratitis.
- The danger is maximum if the patient does not discard the solution or adds only a little more solution.

5 cases in Bern of fusarium keratitis

Out of the 5 cases, 3 were recycled daily lenses.
- It is therefore criminal to allow to recycle daily lenses.
- A daily lens can only be used

ONE DAY

Conclusions

- Have well established routines
- Remember to wash your hands before and after you have inserted a lens in the eye of a patient
- Be careful
- Avoid cases that look like making problems
- Ask for advice to the University Departments or the Committee of the Swiss Ophthalmological Society