CORNEAL HYDRATION...

...A FRAGILE BALANCE

- Epithelial barrier
- Endothelial barrier
- Stromal imbibition pressure
- Intraocular pressure
- Evaporation of the tear film
- Endothelial transport
- Epithelial transport
ØDEMATOUS CORNEAL REACTIONS

CORNEAL DYSTROPHY

- Endothelial dystrophy
- Epithelial dystrophy

POST-SURGERY

- Cataract surgery and corneal œdema
- Corneal graft and corneal oedema

POST-TRAUMATIC

- Recurrent keratalgia
- Non-perforing ocular trauma
Pathophysiological notes

Fuchs dystrophy is the most common cause of decompensation of the endothelial pump. It probably corresponds to a hereditary acceleration of ageing of the endothelium.

Corneal involvement is manifested by protrusions in the Descemet’s membrane, forming “drops” (guttae) and a loss of endothelial cell density. It leads to stromal, then epithelial hyperhydration of the cornea, with bullous keratopathy.

Fuchs dystrophy is a progressive disease that usually appears after 40 years of age. It is more common and more severe in women. The disease can be exacerbated by trauma, surgery, and exposure to toxins and infections. It is not known if the corneal guttae, which tends not to progress, is an entity distinct from Fuchs dystrophy.

Clinical signs and symptoms

It may be entirely asymptomatic and the guttae may only be revealed during a routine SL* examination.

- SL: pigmentation - Specular: atrophy in “drops” (guttae)

The symptoms are worse in the morning

- Vision may be blurred upon waking, a phenomenon that can become permanent in advanced stages
- Glare with a halo around light sources
- Photophobia

Without treatment, the disease can progress to a loss of corneal epithelial sensitivity and corneal opacity.

References

Borderie V, Baudrimont M, Bourcier T. Journal Français d’Ophthalmologie 1999; 22(9); 987.
Therapeutic objectives
Symptomatic:
- Improve morning vision by increasing the osmolarity of the corneal surface, or by drying when going to bed and rising.
- Increase visual comfort to delay the graft
- Surgical treatment by keratoplasty
- The culture of endothelial cells is a future therapy in development

Did you know...
In order to describe the progression of morning visual impairment, Austrian ophthalmologist Ernst Fuchs examined a patient repeatedly at several times during the day. He described the damage caused by the epithelial pathology in his initial description of 1910.

Mechanism of action

**NaCl 5%**
- Osmotic effect\(^{(1)}\)
  - Pumps excess fluid from corneal tissue\(^{(1)}\)
  - Promotes corneal transparency\(^{(2)}\)
  - Improves visual acuity\(^{(3)}\)

**HA 0.15%**
- Protective effect\(^{(4)}\)
  - Stabilises the tear film\(^{(5)}\)
  - Promotes corneal healing\(^{(4)}\)
  - Improves eye comfort

Dosage
1-2 drops 4 times per day, preferably during the first two hours after waking hours, until reduction of oedema\(^{(3)}\).

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EPITHELIAL DYSTROPHY

(e.g.: Cogan's dystrophy)

Pathophysiological notes
This bilateral condition is the most common of the corneal dystrophies (more than 2% of the population).
It is due to an abnormality in the basal membrane of the epithelium, forming intraepithelial gaps; repeated abrasions occur as a consequence of poor epithelial adhesion.
The condition first appears during adolescence. Hypotonicity of the tears in bullous keratopathy causes epithelial œdema, promoting the formation of blisters.

Clinical signs and symptoms
Clinical signs:
- SL*: greyish intraepithelial vesicles, punctate opacities, “fingerprint,” “dot” or “map” lesions most easily visible using retroillumination with dilated pupils

Variable symptoms:
- Tearing
- Visual impairment, loss of visual acuity
- Shooting pain if erosions

Therapeutic objectives
- Improve adhesion between the constituent layers of the cornea.
- Relieve pain
- Lubricate the cornea
- Improve vision
- Limit corneal erosions

*SL: slit lamp.

References
Bourges JL, Dighiero P et al.; la photokératectomie thérapeutique dans le traitement de la dystrophie microkystique de Cogan; J Fr Ophtalmol 2002; 25(6); 594-8.
**Dosage**

1-2 drops 4 times per day during episodes, especially in the evening at bedtime.

**Mechanism of action**

**NaCl 5%**
- Osmotic effect
  - Dehydrates the corneal tissue
  - Promotes epithelial adhesion
  - Prevents recurrence
  - Reduces corneal oedema

**HA 0.15%**
- Protective effect
  - Stabilises the tear film
  - Promotes corneal healing

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**Did you know...**

Phototherapeutic keratectomy is the treatment of choice for forms of the disease resistant to medical treatment, but long-term recurrence remains possible and has been the subject of little research.

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Cataract surgery is the most common ophthalmic intervention. Progress in techniques has helped to greatly reduce the risks of surgery. Nonetheless all intraocular procedures are traumatic for endothelial cells. Anterior chamber implants carry the highest risk for endothelial damage. Postoperative corneal œdema may be either localised or diffuse, stromal and/or epithelial. Persistent pseudophakic corneal œdema is a complication that can become disabling, and remains a major indication for corneal transplants.

Risk factors
Intraoperative endothelial trauma, pre-existing endothelial pathology, significant postoperative inflammation, sustained elevation of postoperative IOP.

Clinical signs and symptoms
Clinical signs:
- Clouded cornea

Variable symptoms:
- Tearing
- Visual impairment
- Loss of visual acuity on waking

Therapeutic objectives
- Evaluation of endothelial cells before surgery
- Respect and protect the corneal tunic during surgery and the postoperative period
- Promote the return of the cornea to its optimal physiological state

References
Hypertonic eye drops may improve vision\(^{(4)}\) pending the graft. In less severe cases and in the presence of risk factors for postoperative corneal œdema, such eye drops may also permit faster recovery of corneal transparency. Where endothelial decompensation is demonstrated, keratoplasty is the only treatment.

**Did you know...**

Endothelial cells have limited mitotic capacity for renewal. After 20 years of age, the loss of endothelial cells is around 0.5% per year. Cataract surgery causes loss of endothelial cells estimated at 9% at 1 year and 12% at 3 years\(^{(1)}\).

In some cases, the endothelial pump can take several months to regain its full capacity and ensure corneal transparency.

**Mechanism of action**

<table>
<thead>
<tr>
<th>NaCl 5%</th>
<th>HA 0.15%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osmotic effect(^{(2)})</td>
<td>Protective effect(^{(5)})</td>
</tr>
<tr>
<td>- Draws fluid out of corneal tissue(^{(2)})</td>
<td>- Stabilises the tear film(^{(4)})</td>
</tr>
<tr>
<td>- Promotes corneal transparency(^{(3)})</td>
<td>- Promotes corneal healing(^{(7)})</td>
</tr>
<tr>
<td>- Improves visual acuity(^{(4)})</td>
<td>- Improves eye comfort</td>
</tr>
</tbody>
</table>

**Dosage**

1–2 drops, preferably 4 times per day until reduction of œdema. In case of blurred vision in the morning: instil during the first two hours after waking\(^{(4)}\).

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Pathophysiological notes
Corneal graft replaces a diseased, opaque cornea with a healthy, transparent cornea.

In cases of irreversible endothelial decompensation, corneal transplantation involves placing a new layer of endothelial cells capable of restoring and maintaining corneal transparency.

The cornea is composed of a dense, avascular connective tissue with few cells, and the transplant success rate is high.

A good prognosis is further improved if the preoperative stromal œdema has been active for a shorter period.

Clinical signs and symptoms

Clinical signs:
- Clouded cornea

Variable symptoms:
- Tearing
- Visual impairment
- Loss of visual acuity on waking

Therapeutic objectives

Before graft: relieve visual discomfort due to œdema, and reduce corneal thickness

After graft: accelerate the return of the cornea to its optimal physiological state

References

Dosage
1–2 drops, 4 times per day until reduction of œdema.

Did you know...
- The first successful corneal transplant was performed in 1905 by Eduard Zirm
- The cornea is the most commonly grafted of solid tissues.

Mechanism of action

**NaCl 5%**
- Osmotic effect
  - Draws fluid out of corneal tissue
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Did you know...
- The first successful corneal transplant was performed in 1905 by Eduard Zirm
- The cornea is the most commonly grafted of solid tissues.

Pathophysiological notes
In this disease, the epithelial surface loses its regularity and exhibits localised œdemas. Recurrent erosions are due to loss of stromal adhesion in the corneal epithelium.

Where the pathology was caused by trauma, the adhesion of scarred epithelium is weakened by a default in the reconstitution of the basal lamina and hemidesmosomes. Erosions occur as the epithelium becomes detached when the eyelids are opened.

Clinical signs and symptoms
- SL*: localised epithelial œdema, no epithelial loss, no blistering and no epithelial cysts.
- Recurrent corneal erosions.
- Rarely occurs bilaterally (10%).
- Recurrent corneal pain, usually upon awakening.
- Photophobia, tearing, eye redness.
- Sometimes significant visual impairment in case of larger erosions.

Causal factors and risk
Occurring spontaneously, the erosions may follow a trauma: scratches by fingernails, paper, make-up implements, foreign bodies, contact lenses, etc.
- Corneal œdema promotes the occurrence of erosive episodes
- Periodic recurrence during menstruation has been described
- Pre-existing corneal dystrophy is a risk factor

*SL: slit lamp.

References
**Dosage**

1-2 drops 4 times per day during episodes, especially in the evening at bedtime.

**Therapeutic objectives**

- Improve adhesion between the constituent layers of the cornea
- Restore corneal structure and form
- Relieve pain
- Accelerate healing
- Limit recurrences

**Did you know...**

In 1941, Dr David Cogan demonstrated the causal link between recurrent erosions and hypotonicity of the tears bathing the cornea during the night, hence the idea of applying a hypertonic solution at bedtime, to dry the cornea.

**Mechanism of action**

**NaCl 5%**

- Osmotic effect
  - Dehydrates the corneal tissue
  - Promotes epithelial adhesion
  - Prevents recurrence
  - Reduces corneal œdema

**HA 0.15%**

- Protective effect
  - Stabilises the tear film
  - Promotes corneal healing

**References**

Pathophysiological notes

Blunt object contusions of the eyeball (caused by sport balls, champagne corks, etc.) can lead to corneal œdema. Generally, the smaller the object, the greater the damage to the eyeball is likely to be. Contusions can affect both the anterior and posterior parts of the eye. If the endothelium is significantly damaged, there is a persistent risk of corneal œdema and bullous keratopathy.

Clinical signs and symptoms

Anterior segment:
- The extent of the œdema depends on the severity of the shock
- The cornea may present erosions and œdema in cases of severe contusion
- Conjunctival hemorrhages should trigger a search for scleral wounds or foreign bodies in the eye
- Hyphema, generally with spontaneous resolution
- Iridodialysis, post traumatic mydriasis
- Subluxation, posterior dislocation of the lens, post-traumatic cataract
- Ocular hypertension

Posterior segment:
- Retinal œdema
- Vitreous haemorrhage
- Torn retina
- Rupture of the choroid
- Very violent trauma may cause rupture of the eyeball

Therapeutic objectives

- Moderate damage to the anterior segment: reduce corneal trauma and promote healing

References

Dosage
1–2 drops, 4 times per day until reduction of œdema.

Mechanism of action

**NaCl 5%**
- Osmotic effect
  - Draws fluid out of corneal tissue
  - Promotes corneal transparency
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  - Stabilises the tear film
  - Promotes corneal healing
  - Improves eye comfort

Did you know...
The deployment of airbags in motor vehicles can cause severe eye injuries, especially in children seated in the front passenger seat. Understanding of this risk has improved the design of airbags, and the risk of eye damage has been much reduced in recent years.

Medical treatment of hypertonicity may be considered

Anterior segment Optical Coherence Tomography and specular microscopy allow the extent of post-traumatic corneal involvement to be monitored.

**1.** Insler MS, Benefield DW, Ross EV, Topical Hyperosmolar Solutions in the Reduction of Corneal Edema, CLAO J. 1987; 13(3): 149-151.


Protective effect

- Promotes corneal healing
- Stabilises the tear film
- Improves eye comfort

HA 0.15%

Filmogenic effect (HA)
CONTRIBUTES TO IMPROVE VISUAL FUNCTION

Osmotic effect

Draws fluid out of corneal tissue

Improves visual acuity

NaCl 5%


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