Influence of topical anaesthetics on Corneal Topography

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Abstract

Introduction: By now it is a well-established fact that topical anaesthetics have an influence on IntraOcular pressure. The topical anaesthetic will give a lower intraocular pressure reading. As a follow-up to this, the aim of this study, is to find out if the topical anaesthetic will give a change in the mapping of the corneal topography.

Setting: The Visimax clinic, Bialystok, Poland

Patient material and methodology: 26 eyes from 13 patients were measured in the study. The topographer used was the BON topographer and tonometry was performed with Icare. The topical anaesthetic used was Alcaine by Alcon.

The following measurements were taken on each eye:

1. Corneal Topography immediately after blink, hereafter wet state c.t.
2. Corneal topography after 15 seconds without blink, hereafter dry state c.t.
3. IOP without topical anaesthetic, called IOP1
4. An interval of 5 to 10 minutes in order for the cornea to “stabilize” after tonometry. This was done to ensure that corneal biodynamics is not playing a role for the sequential measurements.
5. Topical anaesthetics administered, one drop in each eye and an interval of 1 minute was allowed before measurements were resumed.
6. Corneal topography immediately after blink, hereafter wet state an. c.t.
7. Corneal topography after 15 seconds without blink, hereafter dry state an.c.t.
8. IOP with topical anaesthetic, called IOP2

Results and Discussion: The statement in the introduction was confirmed when measuring IOP without and with topical anaesthetic. The IOP is lowered with 2 to 4 mm Hg with an anaesthetic.

The change of corneal topography comparing topographies with and without anaesthetic in both wet and dry state was very small and will not have an influence on surgical outcome in refractive surgery. The maxim change in a few cases was about 1D.
**Conclusion:** Refractive surgery as well as cataract surgery will not affect the final outcome of procedures performed when using a topical anaesthetic. The change in corneal curvature is negligible.

**Introduction**

After the discovery of alterations in IntraOcular pressure when a topical anaesthetic was introduced on the corneal surface, it was of interest to see what influence this type of eye drop would have on the corneal topography. In the era of refractive surgery, it is of great importance for the refractive surgeon to know, if there is any parameter change of the corneal curvature and if so, how much of a change. If there was a change, this change would certainly have an influence of the final outcome and in particular in procedures involving lasers like in PRK, LASEK, Epi-LASIK and LASIK.

Imaging techniques of the anterior portion of the optical system of the eye are developing rapidly, mainly because of recent advances in refractive surgery. To understand the significance of these new imaging techniques, the relevant principles of corneal optics must be understood and to be able to correctly interprete the images of the corneal topography, an overview will follow on these topics. The key question is “On what surface are we imaging”? – On the anterior tear film surface or the anterior epithelial surface of the cornea?

During adulthood, an average cornea is steeper in the vertical meridian by about 0.5D compared to the horizontal meridian, which contributes to a higher incidence of with the rule astigmatism in young adults. This difference between the vertical and horizontal meridians decreases with age and finally disappears by the age of 70. Lenticular changes contribute significantly to the higher incidence of against the rule astigmatism.
The normal cornea has got a prolate shape, ie, steeper in the center and flatter in the periphery. The oblate surface (ie after myopic laser photorefractive surgery) is flatter in the center and steeper in the periphery.

The principles of anterior eye topography are that multiple light concentric rings are projected on the anterior surface of the eye. The reflected image is captured on a charge-coupled device (CCD) camera. Computer software analyzes the data and displays the results in various formats.

The normalized maps have different colour scales assigned to each map based on the instrument software which identifies the actual minimal and maximal keratometric dioptic values of a specific anterior surface of the eye. The dioptic range assigned to each colour is generally smaller compared to the absolute map, and, consequently, maps show a more detailed description of the surface. The disadvantage is that the colours of 2 different maps of 2 different topographers cannot be compared directly, thus having to be interpreted based on the keratometric values from their different colour scales. Different technologies use different measurements and algorithms; thus the output data are not directly comparable. Further, the technologies undergo constant modifications, and the results of studies comparing the instruments are quickly outdated and difficult to interpret for practical clinical purposes.

Coating the outer surface of the cornea is a pre-corneal tear film. The normal blink rate is about every 6 seconds to replenish the tear film. Tears have four main functions on the eye:

- Wetting the corneal epithelium, thereby preventing it from being damaged due to dryness
- Creating a smooth optical surface on the front of the microscopically irregular corneal surface
- Acting as the main supplier of oxygen and other nutrients to the cornea
- Containing an enzyme called lysozyme which destroys bacteria and prevents the growth of microcysts on the cornea.

The tear film resting on the corneal surface consists of 3 layers:

- Lipid or oil layer
- Lacrimal or aqueous layer
- Mucoid or mucin layer
The epithelial surface of the cornea is naturally hydrophobic. Therefore, for a tear layer to be able to remain on the corneal surface without rolling off, the hydrophilic mucoid or mucin layer of the tear film is laid down onto the surface of the cornea by goblet cells. On the other hand, the lacrimal layer of the tear film located above the mucoid layer, can defy gravity and remain in front of the eye.

Methodology

26 eyes from 13 patients interested in refractive surgery, were examined by the same investigator, a normal ophthalmological protocol was followed for the examination. The topical anaesthetic used was Alcaine manufactured by Alcon. For intraocular pressure the Icare from Tiolat was used and a topographer manufactured by BON.
Confirmation of IOP changes due to topical anaesthetic

All tonometers measure IOP indirectly through the cornea. Thus, their accuracy relies on certain assumptions about the cornea – not just about its curvature and thickness but also subtler aspects of the eye wall tissue, which we are only beginning to understand. GAT is based on application of the Imbert-Finck principle to the cornea. He states that the force of flattening (F) equals the pressure (P) multiplied by the surface area flattened (A) or F=PxA. However, this principle assumes that we are examining a dry, perfectly flexible, infinitely thin spherical surface – in other words, a cornea that does not exist.

In the literature, there is more and more evidence of the negative influence of topical anaesthetics on measuring IOP. In this study, this was confirmed.

The influence of a topical anaesthetic on IOP is quite evident from the graph below. IOP measurements were taken by the Icare instrument from Tiolat. The first measurement on the 26 eyes represented above by the blue markings was without anaesthetic and the second measurement represented above by the pink markings was with anaesthetic. There is a significant change in IOP measurements comparing the two, the difference ranging from 1 to 4mm of Hg. The topical anaesthetic is lowering the pressure. An interval of 45 seconds after application of the anaesthetic was used and 6 measurements per occasion were made both without and with anaesthesia. The Icare is
a highly repeatable instrument for measuring IOP with a variability of ± 1mm of Hg per 6 measurements.

One plausible explanation to the decrease of the IOP when using a topical anaesthetic is that there is a swelling of the corneal epithelium as demonstrated by Javaloy and Feinbaum using confocal biomicroscopy.

Confocal biomicroscopy with topical anaesthetic

Confocal biomicroscopy Without topical anaesthetic
The corneal epithelium swells about 30 to 40% and this will contribute to a lowering of the IOP.

Results Flat Meridian

4 measurements of corneal topography were made namely:
1. In wet state just after blink without anaesthetic
2. In dry state 15 seconds after blink without anaesthetic
3. In wet state just after blink with anaesthetic
4. In dry state 15 seconds after blink with anaesthetic

Baseline results in wet state without anaesthetic:

Baseline results flat meridian

26 eyes with a mean corneal curvature of 42.96D in wet state.

Baseline results in dry state without anaesthetic:
26 eyes with a mean corneal curvature of 41.89D in dry state.

Comparison wet to dry state without anaesthetic:

Comparison wet and dry C.T. without anaesthetic in meridian 1
Comparing wet and dry state there is a definite flattening shift from wet to dry, the shift ranging from 0,75D to 1,50D, the mean difference being 1,07D.

Baseline results in wet state with anaesthetic:

<table>
<thead>
<tr>
<th>Number of Eyes</th>
<th>Corneal curvature in Dioptres</th>
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<tbody>
<tr>
<td>1</td>
<td>40</td>
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<tr>
<td>2</td>
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<tr>
<td>3</td>
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<td>10</td>
<td>44,5</td>
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<td>11</td>
<td>45</td>
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26 eyes with a mean corneal curvature of 42,84D in wet state with anaesthetic.

Baseline results in dry state with anaesthetic:

<table>
<thead>
<tr>
<th>Number of Eyes</th>
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<tbody>
<tr>
<td>1</td>
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26 eyes with a mean corneal curvature of 42,13D in dry state with anaesthetic.
Comparison wet and dry state with anaesthetic:

Comparing wet and dry state there is a flattening shift from wet to dry, the shift ranging from 0.82D to 0.62D, the mean difference being 0.72D.

Comparison wet state without and with anaesthetic:
Comparing wet without and wet with anaesthetic the shift is ranging from 0,25D to plano with an average of 0,12D.

Comparison dry without and with anaesthetic:

In the dry state there is a slight shift in mean value comparing without to with anaesthetics, the shift, however, is very slight, less than 0,25D.

Results Steep Meridian

4 measurements of corneal topography were made namely:
1. In wet state just after blink without anaesthetic
2. In dry state 15 seconds after blink without anaesthetic
3. In wet state just after blink with anaesthetic
4. In dry state 15 seconds after blink with anaesthetic
Baseline results in wet state without anaesthetic: