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Research Article

Wet and Dry Corneal Topography? – A New Contraindication for the LASIK Procedure in Refractive Surgery

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Abstract

The corneal topographer is an indispensable tool and plays a critical role in the practice of refractive surgery. In corneal refractive surgery, corneal topography is used preoperatively to detect irregular astigmatism, ectatic corneal disorders, or other abnormalities, and to monitor topographic stability following discontinuation of contact lens wear. Postoperatively, it is used to monitor and assess the surgical outcomes, detect the causes of visual symptoms, and refine and develop surgical techniques for retreatment.

1. Examining the corneal topography carefully is a necessity for a successful corneal ablation procedure like in PRK, LASEK, EpiLASIK and LASIK.
2. However it must be understood that when performing a corneal topography, the anterior surface of the cornea is NOT measured but the anterior surface of the tear film.
3. In this study the topography of the tear film was studied in detail and the topography of this film is called the TOPOFILM.

Keywords: *Corneal Topography; LASIK; Refractive Surgery*

Introduction

The shape of a cornea can be measured and represented by color-coded maps in several ways. A number of different dioptric intervals has been used for color-coded maps and most topographers offer standardized scales and adjustable scales that allow the clinician to customize the information for maximal clinical value. In general, dioptric scales with intervals of 0.5 diopters (D) are recommended and intervals greater than 0.5 D are useful for corneas with large dioptric ranges, such as advanced keratoconus. It is critical to first check the scale and step interval when viewing a color-coded topographic map [1].

Some definitions:

The photokeratoscope view displays the image of placido rings projected on the cornea. It provides important information when assessing the quality of tear film, the centration of measurement relative to the cornea, or the causes of local irregularity.

The axial map displays axial radius of curvature or axial power, which is calculated by referring the optical (or sagittal) axis, as with the manual keratometer.

The tangential map displays tangential/instantaneous/local radius of curvature or tangential power, which is calculated by referring to its neighboring points. The tangential powers often change markedly over smaller regions. This map is very useful in detecting local irregularities, corneal ectactic diseases, or surgically induced changes.

The refractive map displays the refractive power of the cornea, which is calculated based on Snell's law of refraction. Some topographers also incorporate the Stiles-Crawford effect into the refractive power calculation. This map correlates corneal shape to vision.

The elevation map displays corneal height or elevation relative to a reference plane, which may be a spherical or aspherical surface depending on the topographer. It is important to note that the elevation display depends on reference surface size, shape, alignment, and fitting zone. This map shows the three-dimensional shape of the cornea and is useful in measuring the amount of tissue removed by a procedure, assessing postoperative visual problems, or planning/monitoring surgical procedures.

The difference map shows changes or differences in some values between two maps. Different maps are used for monitoring any type of changes, such as recovery from contact lens-induced warpage and surgery-induced changes.

Corneal topography, especially photokeratoscope view and tangential map, plays a critical role in the detection of corneal irregular astigmatism. Causes of the corneal irregularity [2] may be discovered only with careful inspection of the topographic maps, especially the photokeratoscope view (e.g., poor quality of tear film, subtle corneal scar, epithelial basement membrane degeneration) [3].

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 [4]. For topography a topographer manufactured by BON was used.

Figure 1.

Topographical Measurements

2 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

4 measurements sites:

1. Steep central meridian
2. Flat central meridian
3. Steep meridian at 3 mm zone
4. Flat meridian at 3 mm zone

Results

If more than 3 out of the 4 meridians showed a difference of more than 1D, then the topographical data of this patient was studied in more detail.

Comparison wet and dry state in flat meridian centrally:

In the flat meridian centrally, there was a change of 1D or more from wet to dry state in eyes 1, 3, 5, 6, 8, 9, 10, 11, 13, 18, 21 and 23.

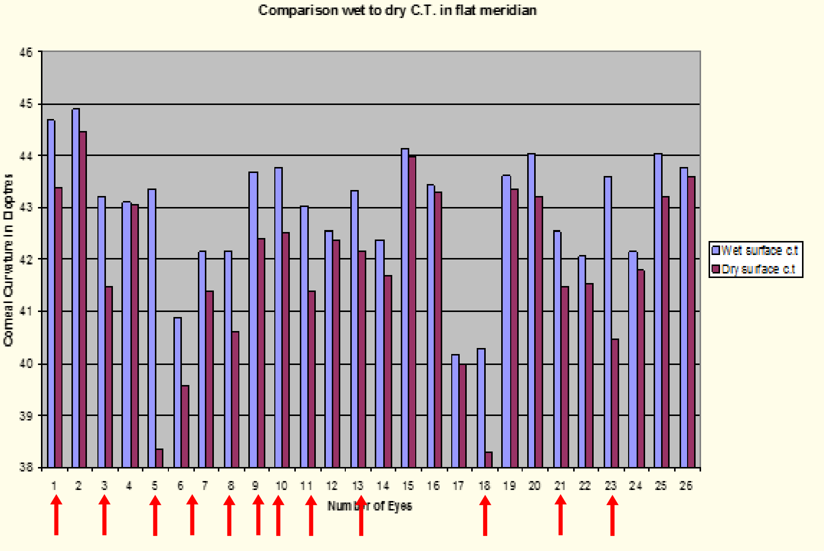

Figure 2.

Comparison wet and dry state in steep meridian centrally:

In the steep meridian centrally there was a change of 1D or more from wet to dry state in eyes 1, 5, 6, 8, 9, 10, 11, 13, 18, 21 and 23.

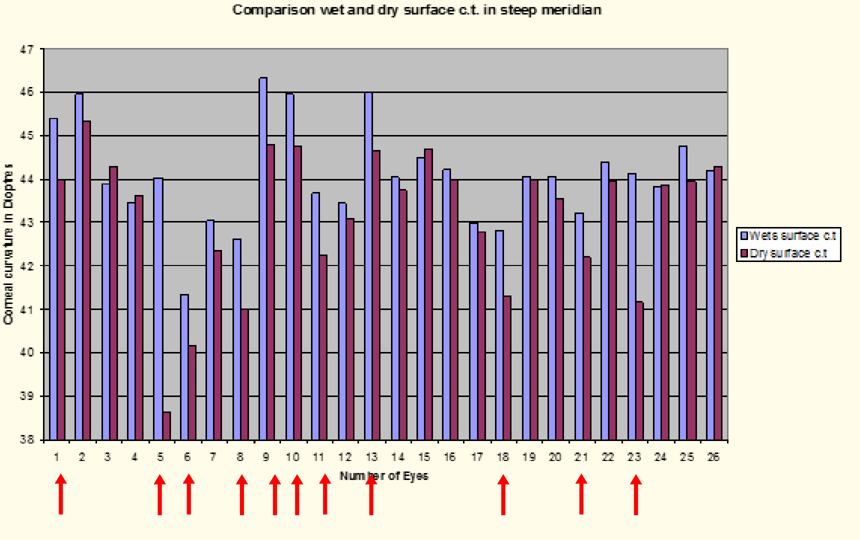

Figure 3.

Comparison wet to dry at 3 mm in flat meridian:

In the flat meridian at 3 mm, there was a change of 1D or more from wet to dry state in eyes 1, 2, 3, 5, 6, 8, 9, 10, 11, 18 and 23.

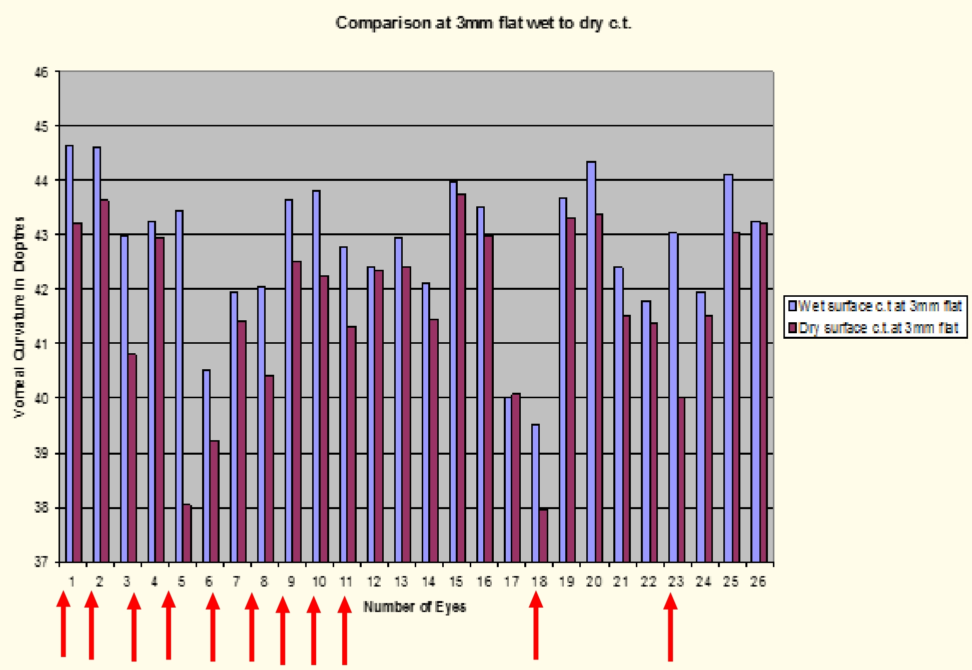

Figure 4.

Comparison at 3 mm steep meridian wet to dry:

In the steep meridian at 3mm there was a change of 1D or more from wet to dry state in eyes 1, 3, 5, 6, 8, 9, 10, 11, 13, 18, 20, 21 and 23.

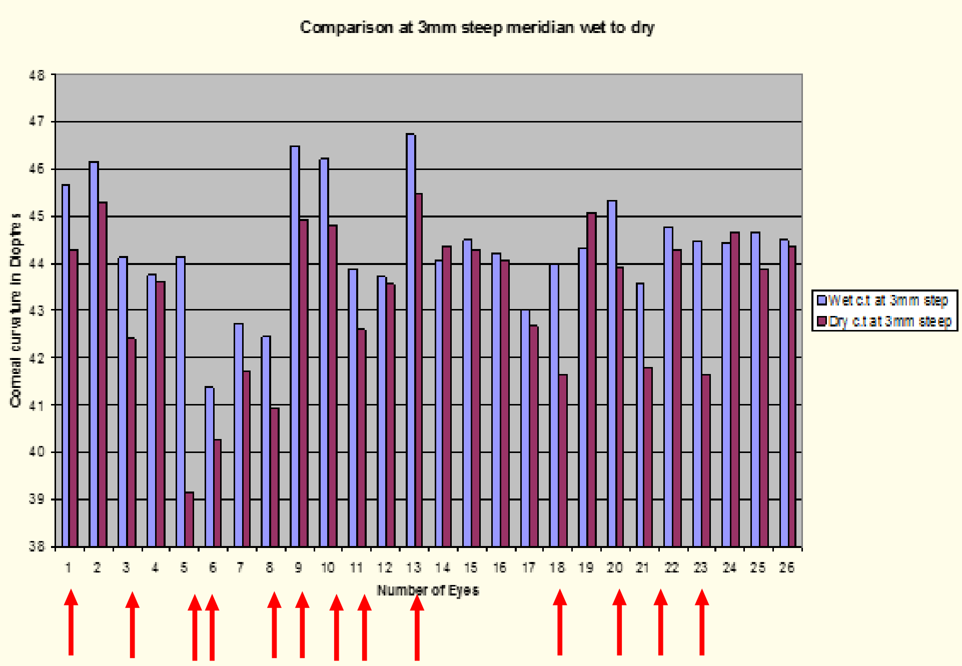

Figure 5.

Summarizing results from above data, there was a change of corneal curvature from wet to dry state in more than 3 out of the 4 meridians in the following eyes: 1, 3, 5, 6, 8, 9, 10, 11, 13, 18, 21 and 23. Thus 12 out of the 26 eyes showed changes from wet to dry topography.

Discussion

The epithelial surface of the cornea is naturally hydrophobic [5]. 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.

A further important factor for the tear film to remain stabile on the corneal epithelial surface is the glycocalix – this substance is found in the surface cells of the corneal epithelium and acts like a glue to the mucoid layer. However, this substance is extremely sensitive and any disturbance to the corneal surface will cause a disappearance of the glycocalix. This disturbance could for example be a surgical intervention or contact lens wear. Therefore in this study it was of greatest importance that the topographies investigated were virginal, i.e. untouched.

Measurements of the tear film thickness in vivo are limited and cannot easily be applied in a clinical setting. The studies on tear film thickness at Ohio State University (Columbus, Ohio) did not confirm Prydal´s estimate of approximately 40 µm. Nor were there prominent peaks near Danjo´s value of approximately 11 µm, except in cases of probable reflex tears. Because the reflection of the aqueous-mucus boundary would be expected to be weaker than that from the epithelial surface, the 3µm peak is unlikely to correspond to the aqueous layer rather than the complete tear film. The proposal that the 3 µm peak corresponds to a reflection from the front of the cornea is supported by the demonstration of a peak of similar contrast from the back of the cornea. Thus, the current evidence consistently supports a value of approximately 3 µm for the thickness of the human precorneal tear film.

A deficient tear film will cause discomfort and a deficiency in any of the three layers of the film can lead to a dry eye condition, causing anything from mild eye irritation to severe pain. Interestingly, in some cases, excessive tearing or watering of the eyes can be a symptom of a dry eye condition. This is because when, for whatever reason, there is an inadequate normal tear layer on the eye, irritation results; the latter causes an overproduction from the lacrimal gland and resulting in a flooding of lacrimal fluid onto the anterior surface of the eye.

A normal tear film has got the following appearance:

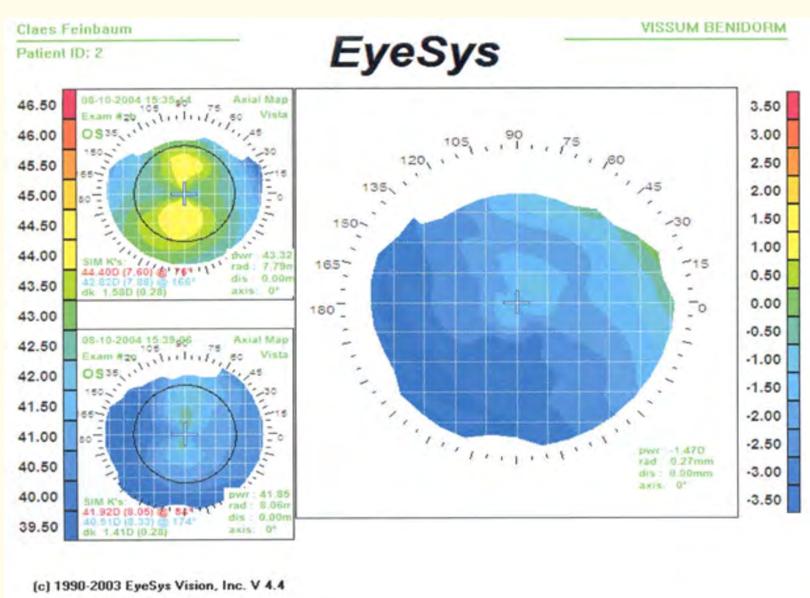

Figure 6.

Montes-Mico., *et al*. have demonstrated that after a blink, the gradual increase in optical aberration associated with the increasingly irregular tear film may cause a progressive reduction in the optical quality of the eye. These changes in aberration with time may partly limit the improvements in visual performance which are achieved by customized corneal ablation.

With the irregular changes occurring when performing corneal topography, as indicated above, the outcome of ablation surface techniques like PRK, LASEK, EpiLASIK and LASIK will vary considerably and cause:

1. Higher order aberrations
2. Dry eyes or better Ocular surface Syndrome
3. Variable uncorrected and corrected visual acuity.

Statistical comment

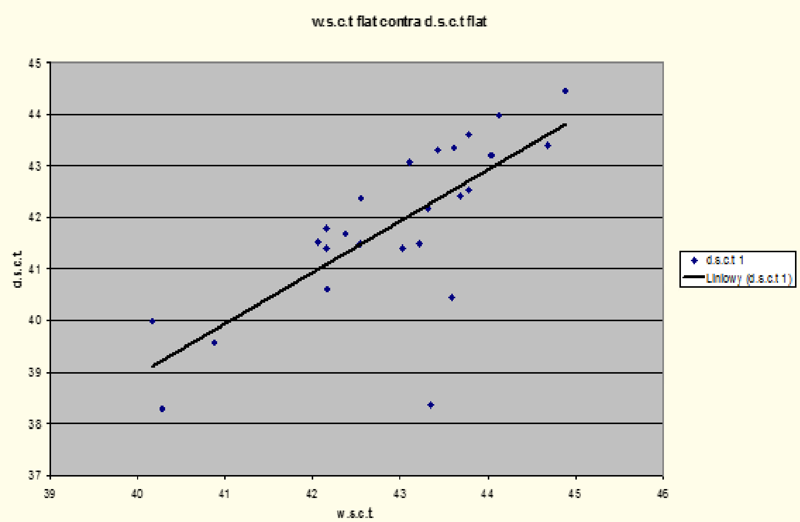

Figure 7.

The p-value from the student t-test in the graph above is 0.009009, thus there is a clinically significant difference comparing wet to dry in the flat meridian centrally.

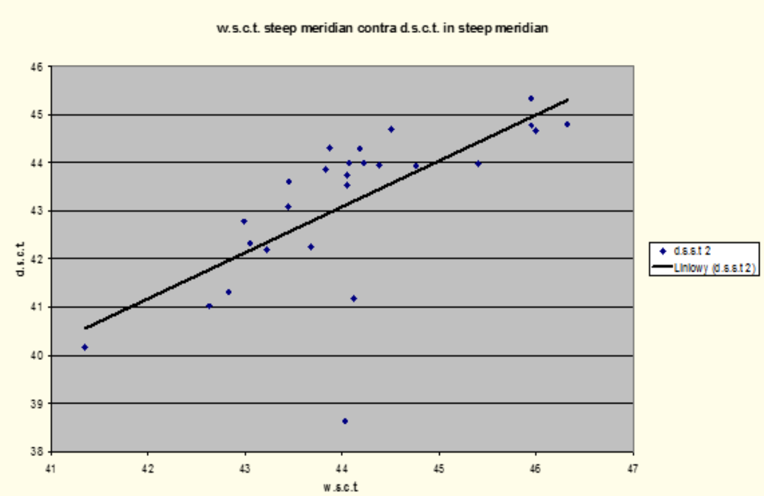

Figure 8.

The p-value from the student t-test in the graph above is 0.022167, thus there is a clinically significant difference comparing wet to dry in the steep meridian centrally.

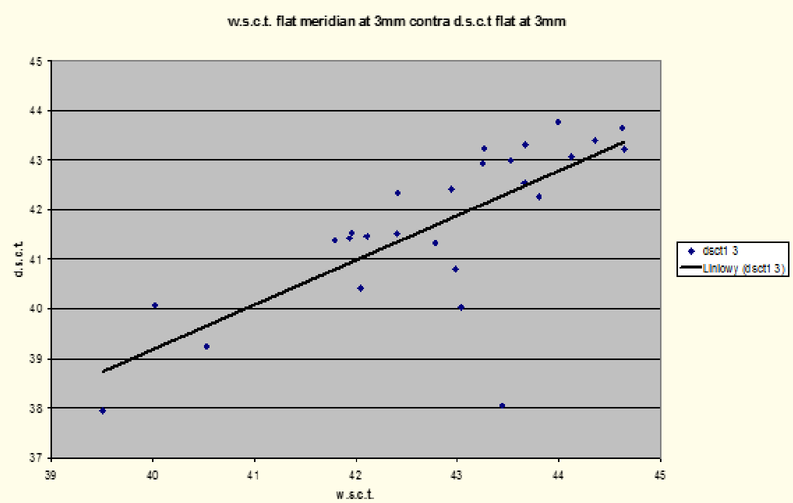

Figure 9.

The p-value from the student t-test in the graph above is 0.010461, thus there is a clinically significant difference comparing wet to dry in the flat meridian at the 3 mm position.

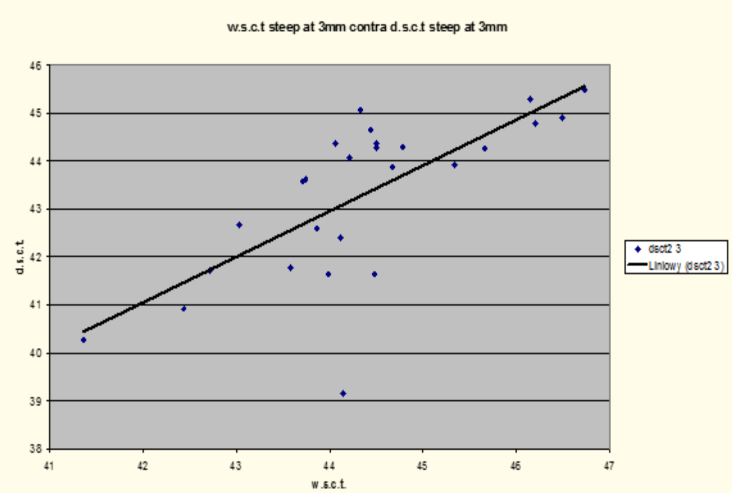

Figure 10.

The p-value from the student t-test in the graph above is 0.011998, thus there is a clinically significant difference comparing wet to dry in the steep meridian at the 3 mm position.

From above statistical data it is clear that there is a topographical change and this change is the same in all directions.

Conclusions

If there are changes in corneal topography [1] in more than 3 out of 4 meridians measured, the outcome of surface ablation techniques will vary considerably due to totally different surface topographies in wet and dry state and the changes are the same in all directions. These surface discrepancies will cause higher order aberrations, dry eyes and variable visual acuity and poor optical quality. It is therefore necessary to change strategy in these cases and use alternative methods.

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