The Performance of a Novel Nanolitre Osmometer to Investigate Diurnal Tear Film Osmolality

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Introduction

- Tear film osmolality is often considered significant in the evaluation of subjects with dry eye.1,2,3 With hypertonicity of the tear film correlating with certain dry eye symptoms. 1,2
- Measuring tear film osmolality is often undertaken using a freezing point depression method.1,2 This typically requires a large volume of tears (5-10µl), which may not be possible with certain dry eye subjects.
- A new freezing point depression osmometer (Model 3100 Tear Osmometer, Advanced Instruments Inc, Norwood, MA – Figs 1a and 1b) requires only a 0.5µl sample to determine osmolality.
- This study was designed to look at the ease of use of the Model 3100 Tear Osmometer in assessing tear film osmolality.
- The study was conducted to look at the osmolality over the course of the day, which has previously been shown to increase towards the end of the day due to increased tear film evaporation.5

Results

- The Model 3100 Tear Osmometer was relatively simple to use.
- The major technique to master related to loading the tear sample into the instrument. However, this was relatively simple to undertake and could be achieved by either clinical or support staff.
- Once proficient in sample loading, the process to obtain an osmolality value was quick and efficient.
- Samples took 10 - 15 minutes to run.
- Tear samples varied in their time to freeze and the crystal patterns obtained varied between subjects (see Fig 4).

Methods

- A 0.5 – 1.0 µl sample of tears was collected from the inferior temporal tear meniscus of the left eye of 40 healthy adult subjects using a single use, disposable polycarbonate capillary tube, without inducing reflex tearing, at a biomicroscope (Fig 2).
- A 0.5 µl sample was then transferred to the osmometer (Fig 3), and an osmolality measurement taken.
- Samples were collected at approximately 9 AM, 12 noon and 4 PM, to investigate tear film osmolality changes over the course of the day.
- Samples were collected at the same times on a second day, to examine the repeatability of the data.
- Subjects completed a simple evaluation of ocular dryness to determine whether they were symptomatic of dry eye. The results of this questionnaire were compared to the osmolality values. 6,7

Dry Eye Symptoms: The subjects in this study were largely asymptomatic, with only 12% categorised as being “moderately dry eyed” based on our questionnaire.

Tear Film Osmolality: The mean ± sd osmolality of the tear film was 306.1 ± 11.9 mOsm, with a range from 266 to 349 mOsm. These values are in accordance with other studies investigating tear film osmolality.1,2,3,4,5

Fig 3 indicates that there was with no significant change in tear film osmolality over the course of the day (p=0.88).

The diurnal variation patterns between individuals showed no general trend (see Fig 6). The osmolality of some individuals did not change over the course of a day, while other individuals showed an increase in osmolality towards the end of the day. Decreases in osmolality from morning to afternoon were also observed, as well as patterns that showed a maximum or minimum value around lunchtime.

Figure 7 – Osmolality compared with dry eye symptomatology

Conclusions

- This study demonstrates that a novel nanolitre osmometer, which requires <1 µl of tears, is a useful tool to determine tear film osmolality.
- The Model 3100 Tear Osmometer is rapid and easy to use, and produces data that is in agreement with that obtained using osmometers that require much larger sample sizes.
- This study indicates that average tear film osmolality varies little over the day, but that individual variations may be significant.
- Further studies are required to determine what factors influence these individual changes.
- Further investigation of the correlation between tear film osmolality and dry eye symptomatology is needed.

References


Figure 5 - Osmolality as a function of time of day

Figure 6 - Individual variations in osmolality over the course of a day, and repeated on a subsequent day.