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Eyelid pressure and contact with the ocular surface

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Abstract

Purpose

To investigate static upper eyelid pressure and contact with the ocular surface in a group of young adult subjects.

Methods

Static upper eyelid pressure was measured for 11 subjects using a piezoresistive pressure sensor attached to a rigid contact lens. Measures of eyelid pressure were derived from an active pressure cell (1.14 mm square) beneath the central upper eyelid margin. To investigate the contact region between the upper eyelid and ocular surface, we used pressure sensitive paper and the lissamine-green staining of Marx’s line. These measures combined with the pressure sensor readings were used to derive estimates of eyelid pressure.

Results

The mean contact width between the eyelids and ocular surface estimated using pressure sensitive paper was 0.60 ± 0.16 mm, while the mean width of Marx’s line was 0.09 ± 0.02 mm. The mean central upper eyelid pressure was calculated to be 3.8 ± 0.7 mmHg (assuming that the whole pressure cell was loaded), 8.0 ± 3.4 mmHg (derived using the pressure sensitive paper imprint widths) and 55 ± 26 mmHg (based on contact widths equivalent to Marx’s line).

Conclusions

The pressure sensitive paper measurements suggest that a band of the eyelid margin, significantly larger than the anatomical zone of the eyelid margin known as Marx’s line, has primary contact with the ocular surface. Using these measurements as the contact between the eyelid margin and ocular surface, we believe that the mean pressure of 8.0 ± 3.4 mmHg is the most reliable estimate of static upper eyelid pressure.
Introduction

The eyelids are in close contact with the ocular surface but the exact pressure and area of contact between the two surfaces is unknown. Previous investigations suggest that the eyelid margin is the main region of the eyelid in contact with the ocular surface. X-ray examination of an individual’s upper eyelid showed close contact between the eyelid margin and cornea \(^1\). This area of the marginal conjunctiva has been termed the lid-wiper as it is thought to be involved in the distribution of the tear film layer during blinking \(^2,3\). Increased staining in this region in dry eye subjects (lid-wiper epitheliopathy) also suggests enhanced frictional contact of this region with the ocular surface \(^2-5\). Another anatomical feature of the eyelid margin is Marx's line \(^6\). This narrow line of squamous cells extends along the entire length of the upper and lower eyelids and can be visualized by staining with rose Bengal or lissamine green vital dyes \(^6-8\). The squamous cell phenotype of this tissue and staining properties of this region suggests that it is subject to mechanical contact and so may be involved in contacting the ocular surface \(^7,9,10\).

There have been three published studies over the past five decades where the authors have designed systems to attempt to measure eyelid pressure \(^11-13\). These techniques have used modified contact lenses to create a chamber which is filled with either air or water and attached to a manometer. The applied pressure is measured from the change in level of the manometer fluid column. These devices were used to measure eyelid pressure while the subjects were instructed to perform "gentle" or “forced” blinks, and static eyelid pressure was not reported. The contact lens devices were relatively thick (up to 2.5 mm) \(^12\) which may have caused distension of the eyelids and influenced the accuracy of the measurements.

The aim of this study was to quantify static upper eyelid pressure (without blinking) using a thin (0.17 mm) pressure sensor mounted on a contact lens \(^14\) for a group of young adult subjects. Due to the dimensions of the pressure measuring cells within the pressure sensor, the contact region between the upper eyelid and ocular surface needed to be considered. As the contact region cannot be directly visualized, three models of eyelid contact with the
pressure cell were based on the sensor’s pressure cell dimensions, images of Marx’s line and eyelid margin contact imprints derived from pressure sensitive paper. These were used to scale the pressure data to estimate the pressure of the upper eyelid margin on the ocular surface.

**Methods**

Eleven subjects were recruited from the staff and students of the Queensland University of Technology School of Optometry. There were 7 female and 4 male subjects of Caucasian (n = 6), Indian (n = 4) and Iranian (n = 1) ethnicity with a mean age of 28 ± 3 years (range 22 to 33 years). Subjects were close to emmetropic with a best corrected acuity of 0.00 logMAR or better and a mean spherical refractive error of +0.10 ± 0.39 D and a mean astigmatism of -0.20 ± 0.31 D. This research was approved by the university research ethics committee and adhered to the tenets of the Declaration of Helsinki. Written consent was obtained from each study participant.

To confirm that all the inclusion and exclusion criteria were satisfied, all subjects underwent a preliminary eye examination. Slit-lamp biomicroscopy confirmed a clear and healthy cornea with no evidence of dry eye, Meibomian gland dysfunction, blepharitis, entropion, ectropion, chalazia or ptosis. Dry eye was defined as a score of ≥ 14 on the McMonnies dry eye symptom survey and a non-invasive tear break up time of < 10 seconds using projected mires[15]. Subjective refraction, using the maximum plus for best visual acuity criteria, was used to confirm refractive status. Since there is evidence that rigid contact lens wear can lead to slight ptosis[16-19] and there are anecdotal reports of ptosis from soft contact lenses[20], all contact lens wearers were excluded from the study. Subjects also had no history of ocular surgery or injury. Due to the eyelid pressure apparatus set up, the right eye was investigated for all subjects.
Eyelid pressure measurement

The development and validation of the eyelid pressure measurement system has been reported in detail \cite{14}. The carrier rigid contact lens was designed based on the average corneal topography data of 100 young, healthy subjects, with a back optic zone radius of 7.8 mm and an eccentricity of $Q = -0.25$ \cite{21}. The contact lens diameter of 15 mm was chosen so that both the upper and lower eyelids rested on the lens. The tactile Tekscan pressure sensor was chosen for this application as it is thin (about 0.17 mm), has a low pressure limit (5 psi), good sensitivity and is suitable for insertion into the eye. The sensor contains piezoresistive ink which responds to mechanical deformation. The change in electrical resistance is recorded through a cable linked to a computer.

Prior to use, the pressure sensor attached to a rigid contact lens was conditioned to improve the consistency of its response. Based on an eyelid pressure of 7.8 mmHg from pilot studies, the sensor was conditioned with four loads of 25.9 mmHg for 1-minute (with 30-second intervals between loads), less than 60 minutes prior to use. A calibration procedure was completed to convert the output from the sensor into actual pressure units. Loads of 1, 2, 2.5, 3, 3.5, 4, 5, 6, 8 and 10 mmHg were each applied twice and a linear fit applied to the average pressure score between 10 and 30 seconds after loading commenced. The mean coefficient of determination ($R^2$) ranged from 0.68 to 0.96, with an average for the 11 subjects of 0.77.

The sensor-contact lens combination was placed on the eye with the tears filling between the back surface of the contact lens and cornea (Figure 1). To obtain a stable measurement of eyelid pressure the subject was required to maintain constant fixation during measurement, with limited eyelid movement. The most stable measurements were achieved when the non-measurement eye was manually held closed by the subject while fixation in the tested eye was maintained in a direction of about 10° downward gaze. Up to five eyelid pressure measurements (each at 5 Hz) were taken until at least two, and preferably three successful measurements were captured (that is, with the eyelid in the correct position on
Figure 1: Front view (top left panel) and side view (top right panel) of an eyelid pressure measurement using a pressure sensor mounted on a specially designed rigid contact lens with plastic support beam. Schematic of sensor-contact lens combination (lower panel) with $R =$ back surface radius of curvature and $D =$ diameter. All curves are spherical with an asphericity $= 0$ unless otherwise stated.
the sensor for at least 20 seconds). With a mean of 2.8 recordings per subject, each of about 12 seconds and at 5 Hz, there was a mean of 168 pressure readings per subject.

Since the region of the eyelid contacting the sensor cannot be visualized during the pressure measurement, a front view video of the eye was recorded to estimate the position of the eyelid margin (front video, Figure 1). This was exported as jpeg images at 5 Hz and later analysed with custom-written image processing software. The eyelid position (i.e. eyelid margin and estimated contact region with the ocular surface) relative to the lower edge of the pressure cell was determined (Figure 2).

A computer program written for Matlab (MathWorks, Massachusetts, USA) was used to filter the sensor’s pressure output data dependent on eyelid position with respect to the pressure cell. The first 10 seconds were discarded due to the initial noisy sensor response \[^{[14]}\]. Outliers (> 1.96 standard deviations from the mean) were removed, most often due to eyelid twitches (i.e. small errors of eyelid movement detected in the front video recording). Assuming that the maximum pressure value occurs when the eyelid is in the correct position on the sensor, 50% of the power of the maximum pressure was used to define a lower boundary limit of data acceptance (upper half criterion). This is equivalent to \(1/\sqrt{2}\) of the signal’s maximum amplitude or the logarithmic -3 dB criterion commonly used in acoustics \[^{[22]}\] and the half width point spread function used in retinal image metrics \[^{[23]}\]. The raw scores within the upper half criterion were averaged and the mean raw score converted to actual pressure units (mmHg) using the corresponding calibration equation. An example of an eyelid pressure measurement and the corresponding eyelid position is shown in Figure 3. While the eyelid moved steadily downwards over the sensor during the measurement (dashed line), the corresponding pressure measurement was approximately a step function (solid line). Eyelid pressure is zero (-1 on the graphed normalised scale) after 52 seconds when the primary contact point of the eyelid has moved downward
Figure 2: Schematic of the eyelid margin contacting the underlying pressure cell: A) side view and B) front view showing the eyelid margin position relative to the lower edge of the pressure cell.
Figure 3: Normalised values for eyelid pressure measurement (solid line) and the corresponding eyelid position (relative to the lower edge of the pressure cell, dashed line). The boundaries for eyelid position corresponding to the maximum pressure and upper half criterion are indicated. In this example the visible eyelid margin was between -0.72 and -0.46 mm below the edge of the cell during valid pressure readings. The mean raw pressure score (prior to calibration) corresponding to this eyelid position range was 79.69 ± 28.46 based on 32 data points.
past the pressure cell. As pressure is no longer measured by the sensor (now well under the eyelid), it suggests that a band of the eyelid margin applies pressure to the ocular surface while the remaining eyelid applies very little pressure (below the measurement noise of this technique).

**Contact region between the eyelids and cornea**

The contact between the eyelids and the ocular surfaces cannot be directly visualized, however the work of Kessing [1] and Korb et al. [2] suggests that a band of the eyelid margin is in contact with the ocular surface. Three models of contact between the surfaces were investigated. The first model assumed that the eyelid contacts the ocular surface over a width greater than or equal to 1.14 mm (the width of the sensor's pressure cell) (Figure 4). This is the value calculated using the calibration data, which assumes that the whole pressure cell is loaded during both calibration and measurement. However if the width of primary contact between the eyelid and cornea is smaller than the pressure cell width (< 1.14 mm), then the calibrated pressure needs to be scaled according to the contact region. We had found in preliminary studies that the sensor output represents total force if the cell is only partially loaded. For example, if only half of the pressure cell was loaded (contact width = 0.57 mm), the pressure reading would be the calibrated by a factor of 2 (i.e. 1.14/0.57). The two other models were based on contact widths less than the pressure cell width of 1.14 mm, measured by pressure-sensitive paper and Marx’s line (Figure 4). So three possible models of contact between the eyelid and ocular surface were investigated along with three corresponding eyelid pressure models: “whole cell” eyelid pressure, “imprint width” eyelid pressure and “Marx’s line” eyelid pressure.

**Imprint width**

To estimate the contact region between the upper eyelid and ocular surface, Pressurex-micro paper (Sensor Products Inc., Madison, New Jersey) was sourced.
Figure 4: Possible models of eyelid contact with the pressure cell: A) the eyelid contacts the “whole cell”; B) contact is over the “imprint width” determined by Pressurex-micro imprint and C) contact over “Marx’s line” width determined by lissamine-green staining and digital photography.
This is pressure sensitive paper consisting of outer plastic protective layers and inner carbon and adhesive layers. It is used to visualize the pressure distribution between opposing surfaces, for example during laminating or between industrial rollers. When pressure is applied a carbon imprint is produced on the adhesive layer.

The specifications suggest a minimum pressure sensitivity of this paper of 2 psi or 103.4 mmHg, however much lower pressures were recorded in trials with known pressures (down to 4.6 mmHg) when the applanation surface was wet. This explains why eyelid margin pressure could be measured despite its pressure being lower than the minimum quoted pressure sensitivity of the paper.

Segments of Pressurex-micro paper were adhered to the flat area of the custom contact lenses with double-sided adhesive tape. The subject’s eye was anaesthetized (0.4% benoxinate) and the contact lens with attached paper was placed on the eye while the eyelids were held open. The upper eyelid was then released to contact the pressure sensitive paper for about 10 seconds during which time the subject was instructed to try to refrain from blinking. The eyelid was then lifted away from the paper and the contact lens removed from the eye. If the subject blinked the test was repeated.

Five separate contact imprints were collected for each subject and digital images of the imprints obtained for analysis (Figure 5). Using custom software, points were chosen along both the upper and lower edges of the imprint, each fit with a 4\textsuperscript{th} order polynomial. The mean distance between the upper and lower boundaries (imprint width) was calculated and averaged for each subject (Figure 6).

\textit{Marx’s line}

Lissamine green was applied to the superior and inferior bulbar conjunctiva of the right eye for each subject using an impregnated strip wetted with two drops of sterile saline and the excess fluid allowed to run off. Digital images of the upper eyelid
Marx’s line were captured by evertng the upper eyelid. These images were analysed with custom software, similar to that used to analyse the contact imprints, with points chosen along the upper and lower boundaries over a 6 mm central portion of the eyelid. This length was chosen to ensure that Marx’s line would be in focus in the digital image for each subject. The upper and lower boundaries were fit with 4th order polynomials and the average distance between the boundaries (mean Marx’s line width) was calculated for each subject (Figure 6).
Figure 5: Example of Pressurex-micro pressure-sensitive paper: adhesive layer attached to the contact lens (left panel), carbon layer placed in contact with the adhesive layer (middle panel) and carbon imprint on the adhesive layer after exposure to eyelid margin pressure and removal of the carbon layer.
Figure 6: Examples of the digital images (top panels) and analysis (middle and lower panels) of a contact imprint width (mean = 0.75 mm) and a Marx’s line width (mean = 0.09 mm). Both widths were averaged over approximately the central 6 mm of the eyelids.
Results

Eyelid pressure was calculated based on the three models of contact between the sensor and eyelid: whole cell, imprint width and Marx’s line (Figure 5). These pressure estimates along with the raw score values for each measurement can be seen in Table 1. The mean “whole cell” eyelid pressure was 3.8 ± 0.7 mmHg, ranging from 2.8 to 5.1 mmHg for the 11 subjects (Table 1).

The Pressurex-micro imprints showed a defined band of pressure between the eyelid margin and the ocular surface. The mean width of the contact imprints was 0.60 ± 0.16 mm with a range from 0.33 mm to 0.84 mm. When eyelid pressure was scaled for each subject using the contact imprint width, the mean “imprint width” eyelid pressure for the 11 subjects was 8.0 ± 3.4 mmHg ranging from 4.4 to 14.4 mmHg (Table 1).

The mean Marx’s line width was 0.09 ± 0.02 mm. The mean eyelid pressure adjusted for a contact width of Marx’s line (“Marx’s line” eyelid pressure) was 55 ± 26 mmHg with a range from 33 to 115 mmHg (Table 1).
Table 1: Eyelid pressure using the three models: whole cell; imprint width and Marx's line. Raw scores are the values obtained from the pressure sensor prior to calibration.

<table>
<thead>
<tr>
<th>Subject number</th>
<th>Raw scores</th>
<th>“Whole cell” eyelid pressure (mmHg)</th>
<th>Imprint width (mm)</th>
<th>“Imprint width” eyelid pressure (mmHg)</th>
<th>Marx’s line width (mm)</th>
<th>“Marx’s line” eyelid pressure (mmHg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>41, 63, 40</td>
<td>3.2 ± 0.6</td>
<td>0.55 ± 0.20</td>
<td>6.6 ± 2.6</td>
<td>0.07 ± &lt;0.01</td>
<td>50 ± 8</td>
</tr>
<tr>
<td>2</td>
<td>81, 119, 91</td>
<td>5.1 ± 0.6</td>
<td>0.40 ± 0.05</td>
<td>14.4 ± 2.4</td>
<td>0.08 ± 0.02</td>
<td>77 ± 19</td>
</tr>
<tr>
<td>3</td>
<td>41, 67</td>
<td>2.9 ± 0.6</td>
<td>0.74 ± 0.08</td>
<td>4.5 ± 1.0</td>
<td>0.09 ± &lt; 0.01</td>
<td>38 ± 8</td>
</tr>
<tr>
<td>4</td>
<td>77, 58, 85</td>
<td>4.9 ± 0.6</td>
<td>0.62 ± 0.05</td>
<td>9.0 ± 1.2</td>
<td>0.05 ± 0.01</td>
<td>115 ± 25</td>
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<tr>
<td>5</td>
<td>35, 47, 51</td>
<td>3.4 ± 0.3</td>
<td>0.39 ± 0.05</td>
<td>9.9 ± 1.5</td>
<td>0.12 ± 0.01</td>
<td>32 ± 5</td>
</tr>
<tr>
<td>6</td>
<td>70, 83, 38</td>
<td>3.9 ± 0.7</td>
<td>0.62 ± 0.13</td>
<td>7.0 ± 2.0</td>
<td>0.09 ± &lt; 0.01</td>
<td>46 ± 9</td>
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<tr>
<td>7</td>
<td>61, 41, 49</td>
<td>4.1 ± 0.4</td>
<td>0.65 ± 0.25</td>
<td>7.2 ± 2.8</td>
<td>0.08 ± 0.01</td>
<td>56 ± 6</td>
</tr>
<tr>
<td>8</td>
<td>46, 47, 25</td>
<td>4.0 ± 0.8</td>
<td>0.33 ± 0.04</td>
<td>13.7 ± 3.2</td>
<td>0.09 ± 0.02</td>
<td>50 ± 15</td>
</tr>
<tr>
<td>9</td>
<td>23, 34</td>
<td>2.8 ± 0.3</td>
<td>0.73 ± 0.01</td>
<td>4.4 ± 0.5</td>
<td>0.10 ± 0.01</td>
<td>33 ± 5</td>
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<tr>
<td>10</td>
<td>36, 37, 37</td>
<td>3.5 ± &lt;0.1</td>
<td>0.84 ± 0.23</td>
<td>4.8 ± 1.3</td>
<td>0.12 ± 0.02</td>
<td>34 ± 5</td>
</tr>
<tr>
<td>11</td>
<td>63, 64, 38</td>
<td>4.4 ± 0.8</td>
<td>0.72 ± 0.10</td>
<td>7.0 ± 1.7</td>
<td>0.06 ± 0.01</td>
<td>79 ± 19</td>
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<tr>
<td>Mean (Sd)</td>
<td></td>
<td>3.8 ± 0.7</td>
<td>0.60 ± 0.16</td>
<td>8.0 ± 3.4</td>
<td>0.09 ± 0.02</td>
<td>55 ± 26</td>
</tr>
</tbody>
</table>
Discussion

The contact imprint widths measured in this study with pressure sensitive paper provide a new estimate of the contact width between the upper eyelid and ocular surface. The imprints confirm previous suggestions that the eyelid margin is the primary contact region with the ocular surface and may represent the zone now defined as the eyelid wiper \[^{[2, 3]}\]. An average contact width of 0.60 mm ranging from 0.33 to 0.84 mm, discounts the “whole cell” eyelid pressure model which assumes a contact width greater than the pressure cell width of 1.14 mm. Primary contact by a band of the eyelid margin can also be seen from the data in Figure 3. When the eyelid margin moved downward past the pressure cell, the eyelid no longer exerted significant pressure on the underlying surface.

Marx’s line is an anatomical feature present in nearly all individuals, with a mean width of 0.09 mm reported in this study in agreement with previous measurements \[^{[9, 24]}\]. Due to its anatomical structure and staining properties it is thought to have frictional contact with the ocular surface \[^{[9]}\] and so can be suggested to be the narrowest possible contact region. The static upper eyelid pressure calculated assuming that only Marx’s line contacts the ocular surface resulted in an average pressure of 55 mmHg ranging from 32 to 115 mmHg. This pressure is quite high considering that intraocular pressure is usually about 15 mmHg and the peak pressure used to deform the cornea by non-contact tonometry is about 90 mmHg \[^{[25]}\]. So it is unlikely that the upper eyelid contacts the ocular surface over a width as narrow as Marx’s line.

The “imprint width” eyelid pressure model based on carbon imprints of the contact between the upper eyelid and ocular surface, in our opinion, provides the most reliable estimate of static upper eyelid pressure. Imprints in the corneal surface due to the upper eyelid have been measured after steady fixation tasks \[^{[24]}\]. The mean width of the peak-to-peak depressions caused by the upper eyelid were 1.3 mm and
1.4 mm after steady fixation conditions at 20° and 40° downward gaze respectively
[24]. It can be assumed that to create the peak-valley-peak profile, tissue or fluid
would be distributed away from the depression. These findings are consistent with
mean imprint contact width (0.60 mm) found in this study being smaller than the
corneal depression peak-to-peak widths (1.3 and 1.4 mm) previously measured.

Further confirmation of the validity of these measurements is the calculation of eyelid
pressure from eyelid tension. While tension does not necessarily directly relate to
pressure, the calculation gives some insight into whether the eyelid pressure
measurements seem reasonable. The eyelid force estimated from measurements
with an eyelid tensiometer [26] is about 30 mN [27]. In comparison, the mean eyelid
pressure of 8 mmHg measured by this study with a piezoresistive pressure sensor is
equivalent to an eyelid force of 19 mN, showing reasonable agreement.

Some comparison can be made to previous eyelid pressure measurements, although
this is limited by different techniques and measurement conditions. Miller [12]
used a manometer system to measure the pressure of a number of subjective blink
conditions: light, gentle, deliberate and hard squeeze. The most comparable to static
eyelid pressure was the light blink condition. The mean result was 2.8 ± 2.2 mmHg
of eyelid pressure. Lydon and Tait [11] appeared to have an improved technique,
however did not provide quantitative values of eyelid pressure. Shikura et al. [13]
found that the average eyelid pressure during normal lid closure was 1.7 mmHg with
a range from -0.50 to 6.7 mmHg. These pressures are lower than the mean
measured by all three models in this study. This is most likely due to the nature of
the manometer systems, which would not measure the localized pressure of the
eyelid margin but would rather determine an average pressure from the upper eyelid
over a much larger area than our technique.

In this study the “imprint width” eyelid pressure varied from 4.4 to 14.4 mmHg. This
range was larger than originally expected, so pressure and imprint measurements
were repeated on two subjects with high and low results to confirm repeatability. The initial pressure measurement for the first subject was 4.5 ± 1.0 mmHg with a repeated value of 4.0 ± 1.5 mmHg, while for the other subject, the initial pressure measurement was 14.4 ± 2.4 mmHg and the repeated measurement was 13.5 ± 3.4 mmHg. With comparable repeated measurements for these subjects, it seems possible that there may be a large range of eyelid pressure between individuals.

It should be acknowledged that there is some thickness of the contact lens and pressure sensitive paper (approximately 0.7 mm) between the eyelid and cornea during the measurement that may slightly alter the contact relationship between the surfaces. However the contact imprint technique directly relates to the eyelid pressure measurement since both are taken using the same thickness of the underlying contact lens. Pilot investigations found that the eyelid had to be in contact with the paper for a minimum of 10 seconds to record an imprint. During this time there may have been some small movement of the eyelid, however it is not known how long the eyelid has to stay in a fixed position to cause an imprint. It can be concluded that the true area of contact between the eyelid margin and the surface of the paper may be slightly smaller than the measured group mean value of 0.60 mm, but probably not larger.

The pressure of the tear film meniscus at the eyelid margin should also be considered in relation to these results. Based on a surface tension of 0.0454 N/m \(^{28}\) and an average tear meniscus radius of curvature of 0.365 mm \(^{29}\), the pressure of the meniscus is 125 N/m\(^2\) or 0.9 mmHg \(^{27}\). This force acts in a direction away from the cornea (opposite to eyelid pressure) and so may be involved in the wave-like corneal surface change (peaks and valley) previously recorded \(^{24}\). However it is unlikely to impact on eyelid pressure measurements, as eyelid pressure and tear meniscus pressure have different locations on the sensor and so are unlikely to be located within the same pressure cell (1.14 mm width), even if the sensor was able to
register negative outward pressure. Therefore it is unlikely that the tear meniscus pressure influenced the eyelid pressure measurements in this study.

It should be noted that measurements in this study were for a static eyelid and eyelid pressure may change during blinking. Previous studies examining a number of blinking conditions found that eyelid pressure increased by a factor of eighteen times between light blinks and hard squeezes of the eyelids \[^{12}\]. Further experimentation with piezoresistive sensors could lead to an understanding of the dynamic nature of eyelid pressure during blinking.

In summary, using the imprint width as the best estimate of the contact between the eyelid and the pressure sensor, the mean eyelid pressure of a group of young adult subjects was 8.0 ± 3.4 mmHg. The contact imprints confirm previous suggestions that a band of the eyelid margin is the primary contact with the ocular surface, with a mean width of 0.60 ± 0.16 mm.

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