Morphology and Function of the Aqueous Outflow System in Monkey Eyes Perfused with Sulfhydryl Reagents
Joann M. Lindenmayer, Michael G. Kahn, Ellen Hertzmark, and David L. Epstein

The aqueous outflow system from anterior chamber to Schlemm's canal was examined by electron microscopy in pairs of enucleated macaque and baboon eyes, perfused via the anterior chamber with mock aqueous humor in one eye and the same fluid with added iodoacetamide (IA) or N-ethyl maleimide (NEM) in the other eye. Many details of the electron micrographs were analyzed in a masked manner using a digitizing bit pad and computer, and also using visual evaluation. Both IA and NEM increased aqueous humor outflow facility, but the morphologic changes induced by IA were quantitatively different from those induced by NEM. Intercellular junctions were not affected by IA, but were disrupted by NEM (P < 0.01). Vacuoles in the endothelial lining of Schlemm's canal tended to increase in area, but not in number, under the influence of IA, whereas they were not so affected by NEM. No loss of extracellular material was observed in either IA- or NEM-treated eyes. The results indicate that the chemical status of cellular-SH groups may influence aqueous humor outflow facility at multiple sites in the outflow pathway. Invest Ophthalmol Vis Sci 24:710–717, 1983.

Perfusion studies previously carried out in this laboratory1,2 and based on earlier work by Bárány,3 have shown that resistance to outflow of aqueous humor in both calf and monkey eyes can be modified by sulfhydryl (-SH) reagents. This -SH effect was shown not to be due to a metabolic inhibitory action on the trabecular meshwork. Rather other factors, such as permeability function of trabecular cell membranes or the integrity of the extracellular matrix, were felt to be possibly responsible for the measured changes in outflow resistance.

Now we have compared morphologic features of the outflow pathways of control eyes with those of eyes perfused with the -SH reagents iodoacetamide (IA) and N-ethyl maleimide (NEM), looking for relationships between changes in function and morphology. In addition, in the course of working out methods for this study we have sought to establish an objective basis for future morphologic evaluation of this tissue.

Materials and Methods

Eyes used for morphologic studies were those in which the effects of IA and NEM on facility of outflow had already been reported by this laboratory.1,2 Eyes were obtained immediately after death from monkeys killed after completion of experiments that did not involve their eyes. The eyes were stored at 4°C in a moist chamber and were perfused within 48 hrs (usually less than 24 hrs). Our standard constant-pressure technique was performed using a Grant stainless-steel corneal fitting.1,2 The medium for perfusion was Dulbecco's phosphate buffered salt solution with added 5.5 mM glucose. Control fellow eyes were perfused in a like manner to experimental -SH reagent-treated eyes with an osmotically equivalent amount of sodium chloride added in place of the -SH agent. Doses of IA and NEM ranged from 15 to 30 μmoles and 1 to 53 μmoles, respectively. Perfusions were performed at 22°C and at 15 mmHg (NEM) or 20 mmHg (IA).

In reporting results we have used a numerical expression for difference in facility of aqueous outflow, δC, in which any change in facility in control eyes during the experiment is subtracted from the change in facility in the experimental (IA or NEM) eye. δC is the difference (experimental − control) between the percent changes in facility over the course of the experiment:

$$\delta C = 100[C2/C1 \text{ experimental minus } C2/C1 \text{ control}]$$
Standard methods of preparation and electron microscopy were employed. Eyes were fixed at a perfusion pressure of 15 mmHg for 12 hrs with 3% glutaraldehyde in 0.1 M sodium cacodylate buffer containing 0.1% CaCl₂. Each eye was bisected at the equator, the lens was removed, and sections of the trabecular meshwork and Schlemm's canal 2 mm long were excised from each of four quadrants, care being taken to avoid the iridotomy site. Specimens were postfixed in 2% osmium tetroxide, dehydrated with a graded acetonitrile series, and embedded in araldite. Thin sections were cut on an LKB microtome, stained with uranyl acetate and lead citrate, and photographed on a JEOL JEM-7 microscope.

The electron micrographs were analyzed in two ways, one objective and the other subjective. These will be described in detail, but, in essence, the objective method was based on tracing micrograph features on a digitizing bit pad and using computer storage and analysis to determine results, while the subjective method was based on visual examination, estimation, and counting.

For the objective portion of the analysis, attempts were made to photograph one entire cross section of Schlemm's canal from each specimen. Thus, where grid bars prevented visualization of a portion of the canal, photographs of the area in question were taken from adjacent sections. Areas of overlap between one micrograph and another were discounted. All micrographs subjected to objective analysis were at 3000X magnification with the exception of micrographs taken of one experiment (experiment 491, taken at 2200X and 4400X). On the average there were seven micrographs per quadrant, or a total of 28 per eye. Each micrograph was evaluated for the following items: number of nuclei (nuclei/tissue area = “cellularity”⁴⁴), number of giant vacuoles (open to Schlemm's canal, open to juxtaglomerular tissue, and intracellular), number of tight junctions and intercellular breaks in the endothelial lining of Schlemm's canal, and width of Schlemm's canal and width of breaks in the endothelial lining. Finally, the total area of the tissue extending 10 microns under Schlemm's canal endothelium (juxtaglomerular tissue) and the portion of that area occupied by cells, extracellular material (amorphous and fibrillar material, and collagen), the three types of vacuoles discussed above, and optically clear space was computed. The latter was calculated according to the following equation:

\[
\text{optically clear space} = \frac{\text{total area 10 microns below Schlemm's canal endothelium} - \text{(cell area + collagen + amorphous material + fibrillar material)}}{\text{Schlemm's canal endothelium}}
\]

Micrograph parameters were determined by tracing the feature on a digitizing bit pad (Summagraphics, Fairfield, CT) that provided 20 X-Y coordinates per second. Areas and/or widths were calculated using a KIM-1 microcomputer. Results were transmitted by the microcomputer to a large remote computer for data storage and analysis. Before statistical analysis, values for each feature in each of the four quadrants were summed, giving total width of Schlemm's canal, total area 10 microns below Schlemm's canal, etc., for each specimen. In an effort to deal with unitless quantities as much as possible, ratios of these totals were computed (eg, percent of total area occupied by cells, percent of width of Schlemm’s canal broken). We also did calculations based on the totals themselves. For the comparisons between control and experimental eyes in a given experiment, values for each eye were computed by taking the mean of the quadrant values and then subjecting these measurements to a two-sided t-test. Comparisons between experimental and control eyes for a given reagent were made by a two-sided, paired t-test.

For the subjective portion of the analysis, a sampling of the lower magnification micrographs previously described, as well as higher magnification (×10,400) micrographs of Schlemm's canal and trabecular meshwork endothelial cells, were used. One high magnification micrograph of each type of cell was chosen randomly from every eye included in this study, and evaluated for condition of the plasma membrane, endoplasmic reticulum, mitochondria, cytoplasm, and nuclei, using a modification of the scale suggested by Trump, Croker, and Meigner.⁶ Low magnification micrographs were similarly evaluated for these parameters as well as for attachments between Schlemm's canal endothelial lining and subendothelial tissue, trabecular endothelial cells and trabecular beams, and trabecular endothelial cells to one another, condition of the trabecular beams, and size of the subendothelial space. Finally, a count was made of Schlemm's canal endothelial cell processes seemingly attached to, and not attached to, subendothelial tissue. To compare the rating distribution for each -SH agent, mean values of the ratings for each eye were subjected to two-sided t-tests paired by experiment.

To avoid bias in evaluation, both low and high magnification micrographs were masked and put into haphazard order by the statistician. The evaluator knew neither which experiment a micrograph belonged to, nor whether it was from a control or an experimental eye. To test the validity of the rating, ten micrographs of each magnification were chosen randomly by the statistician and subsequently reinserted into the remaining stack of photos. The eval-
Table 1. Objective analysis of morphologic features in pairs of eyes from iodoacetamide series (E: experimental; C: control).

<table>
<thead>
<tr>
<th>Exp. no.</th>
<th>Animal type</th>
<th>Dose (μmoles)</th>
<th>δC**</th>
<th>% Cell area</th>
<th>% Extracellular material</th>
</tr>
</thead>
<tbody>
<tr>
<td>634</td>
<td>B</td>
<td>15</td>
<td>26%</td>
<td>32.5 ± 4.6†</td>
<td>8.8 ± 1.8</td>
</tr>
<tr>
<td>491</td>
<td>B</td>
<td>30</td>
<td>28%</td>
<td>38.4 ± 2.6</td>
<td>6.2 ± 1.9</td>
</tr>
<tr>
<td>517</td>
<td>MM</td>
<td>30</td>
<td>42%</td>
<td>28.3 ± 3.7</td>
<td>7.7 ± 0.8</td>
</tr>
<tr>
<td>733</td>
<td>B</td>
<td>15</td>
<td>42%</td>
<td>25.2 ± 1.5</td>
<td>5.8 ± 1.1</td>
</tr>
<tr>
<td>734</td>
<td>B</td>
<td>30</td>
<td>64%</td>
<td>27.7 ± 2.7</td>
<td>7.1 ± 2.0</td>
</tr>
<tr>
<td>221</td>
<td>B</td>
<td>30</td>
<td>253%</td>
<td>16.9 ± 1.6</td>
<td>6.0 ± 0.5</td>
</tr>
</tbody>
</table>

Significance levels: (paired t-test)
(excluding 221)

- * Total area examined (E + C) = ~126,000 μ²
- † Standard error of the mean
- ** δC = 100 [Cj/Cj, exp - Cj/Cj, control]

Results

Validity of Subjective Rating

At least one discrepancy was noted in most of the low magnification micrographs. The magnitude of the discrepancy was usually small (ie, the ratings differed by one scale unit), except for two occasions (in different variables) where the discrepancy was substantial. Five times a feature was judged unratable one time, but rated the other. The least reliable ratings were for junctions between the endothelial lining of Schlemm’s canal and subendothelial tissue, and for Schlemm’s canal endoplastic reticulum (seven and five discrepancies, respectively). Slightly more reliable were trabecular meshwork endoplastic reticulum, compactness of the trabecular beams, and size of the subendothelial space (four discrepancies each). All other variables were determined to be reliable. At least one discrepancy was noted in most of the high magnification micrographs. Of all the variables tested, only evaluation of mitochondria had more than one discrepancy (three).

Analysis of Iodoacetamide Experiments

Objective analysis: No systematic relationship was found between δC and extent of any morphologic abnormality, but when experimental and control eyes were compared as groups (Table 1), the percent of total area occupied by vacuoles, but not the number of vacuoles, was found to be greater with borderline significance in the IA-treated eyes (P < 0.07). If data from experiment 221 are excluded, on the basis that this experimental eye exhibited an extraordinarily large increase in facility and concomitant gross morphologic alteration, this conclusion is strengthened (P < 0.02).

The analysis of totals, rather than ratios, leads to the same conclusions. The total vacuole area was not significantly higher in the experimental eyes (P < 0.07), but the area of closed vacuoles was (P < 0.03). When experiment 221 is omitted, the total vacuole area and the area of closed vacuoles in the IA-treated eyes are both greater than in control eyes (P < 0.03, P < 0.01, respectively).

In the IA-treated eye of experiment 221, the inner wall of Schlemm’s canal was lifted off from the subendothelial tissue, and, compared to the control eye, there was less cell area, more optically clear space, significantly fewer vacuoles, and smaller vacuolar area. There was no difference in breaks in Schlemm’s canal endothelial lining (Table 1). In the other eyes exposed to IA, there were no significant differences in the measured variables other than in the area occupied by vacuoles.

Subjective analysis: At neither low nor high magnification did experimental and control eyes differ with respect to the condition of the cells of Schlemm’s canal and trabecular meshwork. All types of junctions seemed to be maintained equally well in experimental and control groups, even in the eyes of experiment 221.

To ascertain whether the increase in vacuolar area found in the objective analysis represented a loosening of attachments (“feet”) of the endothelial lining of Schlemm’s canal to subendothelial tissue, as has been reported to occur after exposure to cytochalasin B, we counted the number of Schlemm’s canal endothelial processes attached to, and seemingly unattached to, subendothelial tissue, but there was only a suggestion of a decrease in these attachments in IA-treated eyes (P = 0.07).

While experimental eyes were generally indistinguishable from control eyes except for vacuolar area...
(Fig. 1, Table 1) the IA-treated eye of experiment 221 was exceptional. It exhibited gross disturbance of Schlemm's canal endothelium (Fig. 2B). In many places the entire endothelial lining was separated from subendothelial tissue. Intercellular junctions appeared to be maintained, but the cytoplasm of the constituent cells was highly attenuated. The control eye of experiment 221 appeared normal (Fig. 2A).

Analysis of N-ethyl Maleimide Experiments

**Objective analysis:** As with IA, there was no apparent relationship between change in outflow facility and the magnitude of the morphologic changes observed. However, when compared as groups, NEM-treated eyes showed both a greater percent of Schlemm's canal endothelium with broken intercel-

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### Table 1

<table>
<thead>
<tr>
<th>% Optically clear space</th>
<th>% Vacuoles</th>
<th># Vacuoles</th>
<th>% SCE Broken</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>C</td>
<td>E</td>
<td>C</td>
</tr>
<tr>
<td>58.7 ± 3.5</td>
<td>60.3 ± 3.9</td>
<td>23.4 ± 4.1</td>
<td>9.3 ± 1.5</td>
</tr>
<tr>
<td>55.4 ± 1.8</td>
<td>54.1 ± 3.5</td>
<td>41.1 ± 6.6</td>
<td>26.3 ± 2.4</td>
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<td>63.9 ± 2.9</td>
<td>68.3 ± 4.4</td>
<td>12.6 ± 2.2</td>
<td>11.7 ± 0.7</td>
</tr>
<tr>
<td>68.9 ± 1.9</td>
<td>64.9 ± 2.1</td>
<td>27.1 ± 8.8</td>
<td>12.4 ± 5.8</td>
</tr>
<tr>
<td>65.2 ± 4.3</td>
<td>53.0 ± 0.8</td>
<td>24.6 ± 3.7</td>
<td>11.5 ± 2.2</td>
</tr>
<tr>
<td>77.2 ± 2.1</td>
<td>59.0 ± 8.0</td>
<td>2.6 ± 0.9</td>
<td>9.2 ± 2.1</td>
</tr>
</tbody>
</table>

**ns** P < 0.07

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![Fig. 1. Juxtacanalicular area and inner wall of Schlemm's canal from a pair of perfused baboon eyes in which experimental eye (B) received 30 μmoles of iodoacetamide and control eye (A) was sham-injected (IC = 64%). The control eye (A) exhibits a normal-sized vacuole (*) whereas the experimental eye (B) demonstrates a vacuole of increased area (+) (EXP 734; TEM; A: ×4200, B: ×4200).](http://iovs.arvojournals.org/pdfaccess.ashx?url=/data/journals/iovs/933342/ on 05/20/2018)
Table 2. Objective analysis of morphologic features in pairs of eyes from N-ethyl maleimide series (E: experi-
MF: Macaca fascicularis, MM: Macaca mulatta).*

<table>
<thead>
<tr>
<th>Exp. no.</th>
<th>Animal type</th>
<th>Dose (µmoles)</th>
<th>( \delta C^{**} )</th>
<th>% Cell area</th>
<th>% Extracellular material</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>E</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td>E</td>
</tr>
<tr>
<td>565</td>
<td>MC</td>
<td>53</td>
<td>33%</td>
<td>39.0 ± 4.1†</td>
<td>24.2 ± 4.3</td>
</tr>
<tr>
<td>716</td>
<td>B</td>
<td>1</td>
<td>63%</td>
<td>27.2 ± 2.3</td>
<td>29.8 ± 0.9</td>
</tr>
<tr>
<td>499</td>
<td>B</td>
<td>13</td>
<td>119%</td>
<td>37.1 ± 2.2</td>
<td>37.3 ± 3.8</td>
</tr>
<tr>
<td>704</td>
<td>MF</td>
<td>13</td>
<td>140%</td>
<td>36.8 ± 2.8</td>
<td>45.4 ± 4.9</td>
</tr>
<tr>
<td>662</td>
<td>B</td>
<td>13</td>
<td>187%</td>
<td>28.8 ± 2.9</td>
<td>28.9 ± 2.1</td>
</tr>
<tr>
<td>730</td>
<td>MM</td>
<td>1</td>
<td>254%</td>
<td>23.9 ± 4.2</td>
<td>34.7 ± 2.4</td>
</tr>
</tbody>
</table>

Significance levels: (paired t-test)

* Total area examined \((E + C) = ~102,000 \mu^2\)
† Standard error of the mean

NEM, no difference was noted between experimental and control eyes except for disruption of cell-to-cell
junctions in the inner wall of Schlemm's canal (Fig. 3). However, in pairs of eyes with greater than 100%
increase in \( \delta C \), those exposed to NEM were found to have numerous abnormalities. At low magnification,

Subjective analysis: In experiments in which there was less than 100% increase in \( \delta C \) in response to

![image](http://iovs.arvojournals.org/pdfaccess.ashx?url=/data/journals/iovs/933342/ on 05/20/2018)

Fig. 2. Juxtaganular area and inner wall of Schlemm's canal from a pair of perfused baboon eyes in which experimental eye (B) received 30 µmoles of io-
doacetamide and control eye (A) was sham-manipulated \((\delta C = 254\%)\). The en-
thelial lining of the control eye (A) ad-
heres closely to juxtaganular tissue, whereas that of the experimental eye (B) has lifted off from the underlying tissue, and the cytoplasm of the constituent cells is attenuated (arrows) \((\text{EXP. 221}; \text{TEM};
A: \times 5100, B: \times 5400)\).
mental, C: control; MC: Macaca cyclopsis, B: baboon,

<table>
<thead>
<tr>
<th>% Optically clear space</th>
<th>% Vacuoles</th>
<th># Vacuoles</th>
<th>% SCE Broken*</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>C</td>
<td>E</td>
<td>C</td>
</tr>
<tr>
<td>53.5 ± 3.1</td>
<td>70.9 ± 4.5</td>
<td>2.3 ± 1.1</td>
<td>6.7 ± 2.6</td>
</tr>
<tr>
<td>58.7 ± 5.5</td>
<td>58.9 ± 2.0</td>
<td>8.2 ± 2.6</td>
<td>12.3 ± 4.9</td>
</tr>
<tr>
<td>56.0 ± 2.6</td>
<td>54.1 ± 4.1</td>
<td>18.3 ± 4.3</td>
<td>11.0 ± 2.1</td>
</tr>
<tr>
<td>54.2 ± 1.7</td>
<td>48.8 ± 5.0</td>
<td>5.8 ± 2.0</td>
<td>30.7 ± 3.0</td>
</tr>
<tr>
<td>63.9 ± 2.9</td>
<td>63.6 ± 2.0</td>
<td>0.5 ± 0.1</td>
<td>7.0 ± 2.8</td>
</tr>
<tr>
<td>67.2 ± 3.2</td>
<td>54.0 ± 2.2</td>
<td>7.4 ± 0.7</td>
<td>20.0 ± 5.8</td>
</tr>
</tbody>
</table>

ns ns P < 0.05 P < 0.01

all variables, except number of cell processes attached and unattached, and size of the subendothelial space, were found to be affected significantly in both Schlemm's canal and trabecular meshwork endothelial cells. Most junctions were markedly disrupted, as was integrity of the trabecular beams. In high magnification micrographs it also appeared that Schlemm's canal generally remained attached to the subendothelial tissue, even though, in general, cell junctions were not maintained.

**Discussion**

Since most iodoacetamide-treated eyes exhibited a slightly larger area of vacuoles, but not a greater number of vacuoles than did control eyes, and since there was only the suggestion of a decrease in attachments of the endothelial lining of Schlemm's canal to subendothelial tissue, we do not know whether the apparent increase in vacuolar area can correctly be explained by the slight loss of subendothelial attachments, or whether it represents a more direct effect of IA on the endothelial cell membrane of the inner wall of Schlemm's canal.

In experiment 221, the unusually large δC was probably associated with lifting off of the inner wall of Schlemm's canal from subendothelial tissue. Since the percent of the endothelial lining of Schlemm's canal with broken cell-to-cell junctions in this experimental eye was no different from that in the control, the increase in facility induced by IA is probably not attributable to an action on intercellular junctions in the inner wall of Schlemm's canal.

There is good evidence to indicate that NEM acts differently from IA, since NEM disrupted intercellular junctions in the inner wall endothelium of Schlemm's canal, whereas IA did not (Table 2, Fig. 3). It is interesting to note that even at doses of NEM that caused severe cellular changes, the endothelium of the inner wall generally remained attached to the subendothelial tissue. The decrease in number of vacuoles that we found with NEM could be accounted for by diversion of flow between inner wall endothelial cells, which we expect would occur as a consequence of disruption of intercellular junctions. Intercellular diversion of fluid flow has been reported in eyes where intercellular junctions have been ruptured by EDTA, EGTA, or calcium-free medium. However, in the case of calcium depletion the effect on intercellular junctions must be different, since junctional repair has been noted to occur when calcium is replenished (9,10) (In our experiments with NEM there was no calcium deficiency.)

Our observations with NEM are similar to those reported for corneal endothelium following exposure to the sulfhydryl oxidant, diamide. It is possible, as in diamide-treated corneas, that disruption of endothelial junctions in our NEM-treated eyes may be due to a similar intracellular effect on the microfilament network.

There is a widely held belief that vacuole formation is the principal mechanism for outflow of aqueous humor through endothelial cells of the inner wall of Schlemm's canal. The normal tight junctions between these inner wall endothelial cells appear to allow little paracellular flow of fluid. By disrupting these junctions, NEM may produce an abnormal pathway for aqueous humor outflow, bypassing the vacuole mechanism, and possibly altering the pressure gradient at this particular site. We have no explanation for why IA, rather than disrupting these
intercellular junctions, may affect either the permeability of inner wall endothelial cells and the vacuolization process itself, or may affect the resistance just proximal to the endothelium of the inner wall and, to judge from one eye, appears to loosen the attachments of the latter to the subendothelial tissue.

With both IA and NEM we found an inconsistent relationship between the magnitude of increase in facility of outflow and extent of morphologic change induced by these agents. We suspect that one probable reason for this finding is that there was considerable variation in the concentration of these agents when they were used. The peak of facility response in subhuman primate eyes is obtained with a dose of 1 \( \mu \)mole NEM. Larger doses may actually produce smaller increases in facility. We postulate that this may reflect initial shrinkage and subsequent swelling of trabecular endothelial cells as they are exposed to increasing concentrations of NEM, an effect that has been reported to occur in red blood cells. It seems consistent with this hypothesis that among the six pairs of eyes in the NEM-exposed group the greatest difference in trabecular cell area (E > C) was observed when 5C was lowest (33%), and the greatest difference (C > E) was observed when 5C was highest (254%).

Other possible explanations occur to us that could explain why we found no correlation between facility differences and extent of morphologic changes in eyes exposed to IA or NEM. According to Poiseuille's law, very small structural changes could lead to large increases in facility of outflow, and perhaps our method of analysis does not allow structural differences of this magnitude to be detected. It is possible that morphologic parameters different from those that we studied were, in fact, more critical to these -SH-induced changes in outflow function.

Yet another possible explanation is that the observed facility increase could be due in part to washout of glycosaminoglycans (GAGs). Francois has suggested that the presence of GAGs in the outflow pathways helps to regulate the outflow of aqueous humor. Others have suggested that a washout of GAGs from these pathways is responsible for the facility increases observed in perfusion experiments. In our studies with NEM and IA we found no change in extracellular material. However, our method of processing specimens may have allowed loss of GAGs to occur and may be inadequate to evaluate the amount of residual GAGs. We have not specifically evaluated the effects of -SH agents on these extracellular compounds. It will be important to perform further studies using ruthenium red to detect the presence of GAGs.

Our previous biochemical studies of subprimate trabecular meshwork excised after perfusion indicated that the effect of -SH agents on outflow resistance was not due to a metabolic inhibitory action on glycolysis and energy production. The present
morphologic investigation substantiates that these -SH-induced changes in outflow are not explained by a simple cytotoxic action. We hypothesize that the reagents used affect cell membrane -SH groups in the trabecular meshwork and thereby alter the dimensions and resistance of the aqueous outflow pathway. With NEM the effect seems clearly related to the disruption of the intercellular junctions in the inner wall of Schlemm's canal, whereas with IA either the subendothelial pathway or the flow through the inner wall endothelial cell or both seem to be altered. Cell membrane -SH groups are known to influence cellular and paracellular fluid flow in other tissues.19

Our results suggest that the chemical status of cellular -SH groups may influence aqueous outflow at multiple sites in the outflow pathway. We speculate that modification of these -SH groups offers a potentially important means of altering and studying aqueous humor outflow resistance.

Key words: sulfhydryl groups, iodoacetamide, N-ethyl maleimide, outflow facility, vacuoles, cell membrane permeability, intercellular junctions, glaucoma

Acknowledgments

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References