Mode of action of cyclodialysis implants in man

James Pitzer Gills, Jr., C. A. Paterson, and M. E. Paterson

Intraocular manometric procedures performed on two human eyes before and six months following cyclodialysis with implants showed an increase in facility of outflow and a decrease in aqueous formation.

Heine\textsuperscript{10} described the use of cyclodialysis in the treatment of glaucoma in 1905. Salus,\textsuperscript{13} Elschnig,\textsuperscript{6} Barkan,\textsuperscript{1} and Sugar,\textsuperscript{14} suggested that the effect of cyclodialysis depended upon the improvement in facility of outflow and/or decrease in aqueous formation. Kronfeld\textsuperscript{12} believed the mechanism of action of cyclodialysis eyes with relative hypotony was due to "a greatly reduced rate of formation of aqueous." Goldmann\textsuperscript{8} studied the cyclodialysis by means of fluorescein techniques in four patients. He noted a reduction in the rate of flow in the first case from 1.5 $\mu$L per minute before the operation to 0.17 $\mu$L per minute two weeks after the operation. In a second case, the flow rate dropped from a preoperative value of 1.5 $\mu$L per minute to a 9½ months postoperative value of 0.9 $\mu$L per minute. His findings suggest that, in addition to a decrease in aqueous formation, there is an increase in facility of outflow in the months to years following cyclodialysis. Goldmann noted that the outer surface of the choroid had an abundance of veins, and thus, a high absorption potential. Becker and Friedenwald\textsuperscript{2} noted that with cyclodialysis the facility of outflow, as measured by tonography, was increased in most cases. Some cases, however, were noted to have a satisfactory reduction in intraocular pressure but little, if any, improvement in facility of outflow. Kronfeld\textsuperscript{11} noted that detachment of the ciliary body had a pronounced depressive effect upon the secretory function of the ciliary body, the depression of aqueous secretion being a strong tension lowering factor. Chandler and Maumenee\textsuperscript{1} discussed detachment of the ciliary body as a major cause of hypotony. Gills, Paterson, and Paterson\textsuperscript{7} performed intraocular manometric studies on 16 macaque eyes after cyclodialysis with the use of implants. Their findings suggested decreased aqueous formation as the main mechanism of action in this type of cyclodialysis.

The purpose of this work was to study the mode of action of cyclodialysis implants. This report summarizes the findings from intraocular manometric studies in two human eyes before and following cyclodialysis implants.

Intraocular manometrics in two human eyes

In two human eyes, intraocular manometric procedures were performed before
Fig. 1. 1, Two 2 mm. trephines, 1.5 mm. apart, 8 mm. from the limbus, are placed in an area of the superior sclera. An attempt is made to place the trephines in the axis of the minus astigmatic correction. By multiple thrust a quadrantic cyclodialysis is performed. 2, Scleral incisions, 1 to 2 mm. long, are made at the edge of the trephines in the direction in which the arms of the implant are to lie. This helps fix the tube. A 16 to 18 mm. Teflon tube 1 mm. in diameter is incised longitudinally for 3 mm. at the middle of the tube (a). The Teflon tube is placed on the special forceps and inserted into the cyclodialysis cleft. 3, The tube is positioned in the cleft and held there while the forceps are removed. 4, The implant tends to straighten, holding open the cyclodialysis cleft and fixing itself. The implant lies at least 2 to 4 mm. from the anterior chamber in the cyclodialysis cleft. Decadron (8.0 mg.) is given following each operation. Atropine (3 per cent) and local steroids are given every hour during the postoperative course. (From Gills, J. P., Jr.: Am. J. Ophth. 61: 1966.)
Fig. 2. Conioscopic view of cyclodialysis cleft. The implant that holds the cleft open is not visualized. Arrows point to the cyclodialysis cleft.

and six months after cyclodialysis operations with the use of Teflon implants (Figs. 1 and 2). In the first eye, in which a cyclodialysis implant was inserted, there was chronic angle closure with extensive peripheral anterior synechiae. This eye exhibited not only a decrease in the aqueous formation following the operation but also an increase in the facility of outflow. The increased facility was more striking when determined by intraocular manometric procedures* (0.29 to 0.69 µL per minute per millimeter of mercury) than by tonographic studies (0.20 to 0.29 µL per minute per millimeter of mercury). Recovery curves showed a marked reduction in the rate of rise in intraocular pressure following cyclodialysis (0.44 to 0.17 mm. Hg per minute), suggesting decreased aqueous formation (Table 1).

Comment

Intraocular manometric and tonographic measurements have been made in two human eyes prior to and six months after cyclodialysis utilizing implants. Following the cyclodialysis the rate of aqueous formation, as judged by recovery curves and calculated from tonographic measurements, was significantly decreased. There was also an increase in the facility of outflow in the eyes following cyclodialysis with an implant.

We have found the area of the cyclodialysis to be generally proportional to the hypotensive effect in 47 eyes operated upon with the use of cyclodialysis implants. The decrease in aqueous formation was most marked in the immediate postoperative period when the eyes were in relative hypotony. The mechanism by which aqueous formation is decreased remains a matter of speculation. The increase in facility of outflow is probably the result of the formation of new aqueous outflow channels. These channels may simply consist of an enlargement of the unconventional outflow channels of the uveal and sclera.8

Table I

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Tension (mm. Hg)</th>
<th>Facility of outflow (µL/min./mm. Hg)</th>
<th>Recovery curves (mm. Hg/min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>47</td>
<td>10</td>
<td>0.29</td>
</tr>
<tr>
<td>2</td>
<td>42</td>
<td>14</td>
<td>0.14</td>
</tr>
</tbody>
</table>

*Facility of outflow was studied by pressure decay curves and steady-state infusions.
†Recovery curves; the intraocular pressure was lowered 3 mm. Hg below steady-state levels by means of a saline reservoir. The pressure was then allowed to rise. The rate of rise is an index of aqueous production.
The results obtained from both tonographic and intraocular manometric measurements in the eyes following conventional cyclodialysis\(^1\) \(^6\) \(^11\) \(^12\) and after cyclodialysis with implants are similar. This similarity suggests that conventional cyclodialysis and cyclodialysis with implants have a common mode of action. Clinically however, cyclodialysis with an implant to prevent closure of the cleft seems, in our hands, to provide a more satisfactory and predictable pressure-lowering operation than conventional cyclodialysis.

REFERENCES
5. Elschng, A.: Zur Wirkungweize der Cyklo-

Discussion
From the audience. How do you know your whole effect is not due to separation of the ciliary body?

Dr. Gills. Well, there is the work that I did several years ago, by just inserting the implant into the suprachoroid. We did get a hypotensive effect in cats, with no increase in facility of out-

From the audience. How do you calculate the facility of such an eye when you don’t know the venous pressure?

Dr. Gills. In our work using tonography we have to assume that the \(P_v\) is the same, but in reality we know it is not because we actually established new outflow mechanisms.

Dr. Becker. \(P_v\) does not enter the tonography calculation directly. It doesn’t matter what \(P_v\) is just so it does not change during the tonogram. It is important to point out that the unconventional channels of outflow you refer to are not pressure sensitive. Therefore they do not give increased outflow facilities but appear as “negative secretion.” You may want to consider the pseudofacility. This could increase the apparent facility as measured by tonography without true change in facility. It involves an effect of pressure on the rate of secretion.

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