Outflow of Aqueous Humor following Cycldodialysis or Ciliochoroidal Detachment in Rabbit

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Cycldodialysis and ciliochoroidal detachment were performed in three eyes of three rabbits and in three eyes of another three rabbits, respectively. After aspiration of the aqueous humor, 0.1 ml of 10% sodium fluorescein was injected intracameraly, and the eyeball was enucleated between 30 minutes and one hour after injection and prepared for fluorescence microscopy. Sodium fluorescein concentrations in the suprachiorial space were much greater in the group with cycldodialysis or ciliochoroidal detachment than in the normal control group. These results suggest that (1) in the eye with cycldodialysis, the aqueous humor may freely gain access to the suprachiorial space through the cleft between the anterior chamber and the suprachiorial space and then be removed rapidly and (2) in the eye with ciliochoroidal detachment, the aqueous humor may pass through the uveoscleral outflow pathway.

Key words: ciliochoroidal detachment, cycldodialysis, uveoscleral outflow.

INTRODUCTION

It has been demonstrated by many investigators\textsuperscript{1-9} that various materials pass from the anterior chamber through the ciliary body and the iris into the suprachiorial space. It has also been well-known both clinically and experimentally that cycldodialysis or ciliochoroidal detachment frequently accompanies hypotony. The mechanism is not clear, but possible explanations for it are the direct reduction of aqueous humor production; reduced aqueous production presumably due to a breakdown in the blood-aqueous barrier by combined iridocyclitis; and finally enhanced fluid exchange between the anterior chamber and the suprachiorial or suprachiorial space owing to the presence of interstitial edema of the ciliary muscle and the eventual increase of the uveoscleral outflow.\textsuperscript{10-15}

The purpose of this study was to observe the outflow of aqueous humor with fluorescent dye in cycldodialysis or ciliochoroidal detachment and to evaluate the effect of cycldodialysis or ciliochoroidal detachment on the uveoscleral outflow.

MATERIALS AND METHODS

Six pigmented rabbits weighing between 2.0 and 3.0 kg were used in this study. In three eyes of three rabbits cycldodialysis was performed, and in three eyes of another three rabbits ciliochoroidal detachment was performed. The remaining six eyes of all the rabbits served as the control group.

After the experimental animal was administered intramuscular Ketamine hydrochloride (30–50 mg/kg) cycldodialysis was performed using

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the classical Heine technique as follows: Sclerotomy was performed under a limbus-based conjunctival flap down to the uveal tissue 4 mm posterior and parallel to the limbus for 3 mm in extent. A cycloidalysis spatula was inserted radially until the tip was seen entering the anterior chamber and made a fan-shaped sweep about 180° in extent.

Ciliochoroidal detachment was performed as follows: Hypotony was induced after aspiration of 0.2 ml of vitreous with a 25G tuberculin syringe 4 mm posterior from the limbus. Sclerotomy was performed at the aspiration site 4 mm in extent, and after exposure of the ciliary body, sodium hyaluronate was injected into the supraciliary space about 180° in extent both anteriorly and posteriorly from the sclerotomy site.

Anterior chamber paracentesis followed these procedures for aspiration of 0.1 ml of aqueous humor and injection of the same amount of 10% sodium fluorescein. The rabbit eyes were enucleated between 30 minutes and one hour after paracentesis, and three-by-four millimeter tissues from the lesion site were obtained and embedded in Tissue-Tek®. Tissues were then frozen to −70°C, sectioned with cryotome 20 μm in width and examined by a fluorescent microscope (Nikon, Japan).

RESULTS

In the control eye, the trabecular meshwork was loosely arranged and the fluorescence was seen within the anterior chamber, intertrabecular space and the stroma of the ciliary body(Fig. 1).

Also, the iris stroma showed a diffuse fluorescent pattern, and prominent fluorescence was seen in the perivascula space(Fig. 2).

In the eye treated with cycloidalysis, the fluorescence was observed in the anterior chamber, supraciliary space and the cleft between them(Fig. 3). However, in contrast to the control eye, the fluorescence in the supraciliary space in this case was more intense(Fig. 4). In the eye with ciliochoroidal detachment, the fluorescence was noted in the supraciliary space and the stroma of the ciliary body, but the intensity of the fluorescence was less prominent than that in the eye with cycloidalysis (Fig. 5). Also, hyperfluorescence was shown in the perivascula space in the stroma of the ciliary body(Fig. 6).

DISCUSSION

Although the aqueous humor usually leaves the anterior chamber through the trabecular meshwork and the canal of Schlemm, according to Fine1, there are three drainage pathways from the anterior chamber: through the trabecular meshwork and the canal of Schlemm; through the anterior limiting membrane in crypts of iris or intercellular space and the capillaries within the iris stroma; and finally through the ciliary muscle, intrascleral plexus and then the collector channels.

Also, Bill2 has demonstrated in men and experimental animals that the aqueous humor passes from the anterior chamber and the trabecular meshwork along the ciliary muscle into the suprachoroidal space, and the aqueous leaves the suprachoroidal space mainly along the perivascular space and directly through the scleral tissue. He termed this process “uveoscleral outflow”, which ranged from 20 to 35% of the total aqueous outflow in monkey and from 4 to 27% in men.

Cycloidalysis, separation of the ciliary body from the scleral spur, usually leads to hypotony14. It was thought that cycloidalysis caused a reduction of aqueous formation, resulting in hypotony and that, alternatively, hypotony was caused by an increase in outflow facility due to the fluid movement through the cleft into the suprachoroidal space11. In our study, the fluorescence in the perivascular space of the ciliary body and supraciliary space explained the presence of the uveoscleral outflow in the normal control eye. Also, in the eye with cycloidalysis, we found the fluorescent dye present in the anterior chamber, supraciliary space and the cleft. Especially there was hyperfluorescence in the supraciliary space. Judging from this finding, there might be an increase of aqueous outflow directly through the cleft into the supraciliary space. Based on these observations, as previously described by Nesterov16, cycloidalysis may serve as a method of surgery in reduction of IOP in glaucoma patients. Although Toris et al.11 demonstrated that the aqueous humor in the supraciliary space passed through the sclera and emissarial channels, or was absorbed by the uveal blood vessels, we could find no evidence for an increase of uveoscleral outflow in the eyes with
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cyclodialysis.

Ciliochoroidal detachment, in which fluid collects between the uvea and the sclera, frequently accompanies hypotony, and the exact mechanism is controversial. Pederson and Pederson et al. have documented that ciliochoroidal detachment causes hypotony due to an increase in uveoscleral outflow. In this study, we found the fluorescence within the anterior chamber, suprachorial space and the stroma of the ciliary body in the eyes with ciliochoroidal detachment. Intense fluorescence was also seen in the perivascular space in the stroma of the ciliary body and in the suprachorial space. These findings which suggest that fluorescent dye passage increases through the uveoscleral outflow, are in agreement with other studies involving uveoscleral outflow.

The eyes with cyclodialysis or ciliochoroidal detachment were found to be very low in tension on palpation, more so than in the normal control eyes when performing enucleation. On the basis of the same amount being removed and injected through the paracentesis, it seems that hypotony is induced by the above-mentioned mechanisms between 30 minutes and one hour after paracentesis.

In summary, the present study shows that uveoscleral outflow exists in rabbit eye, and the increase in outflow facility may contribute to the hypotony in cyclodialysis or ciliochoroidal detachment.

REFERENCES

LEGENDS FOR FIGURES

Fig. 1. Control eye. Diffuse fluorescence is seen in the anterior chamber(arrow) and also in inter trabecular space(arrowhead). Fluorescence is also observed in the stroma of the ciliary body(large arrow)(×100).

Fig. 2. Control eye. Iris stroma shows diffuse fluorescence and prominent fluorescence is seen in perivascular space(P)(×100).

Fig. 3. Eye with cyclodialysis. Prominent hyperfluorescence is shown in the cleft(C) between anterior chamber and supraciliary space(×40).

Fig. 4. Eye with cyclodialysis showing hyperfluorescence in supraciliary space(arrow)(×10).

Fig. 5. Eye with ciliochoroidal detachment. Fluorescence is noted in the stroma of the ciliary body(CB)(×40).

Fig. 6. Eye with ciliochoroidal detachment. Hyperfluorescence is seen in the perivascular space(P) in the stroma of the ciliary body(×100).