from the National Eye Institute of the National Institutes of Health. Submitted for publication Feb. 8, 1974.

REFERENCES

Intraocular pressure following long posterior ciliary canal cautery in primates. NORMAN S. LEVY, STEVEN S. SPECTOR, AND C. IAN HOOD.

Cautery to both long posterior ciliary canals resulted in lowering of the intraocular pressure in squirrel monkeys. This response persisted over a four-week period. Although latex injection at the time of death suggested obstruction of the long posterior ciliary arteries, neither injury nor closure could be confirmed histologically. The inability to obtain permanent closure of these vessels may be due to their depth in the suprachoroid at the point of cautery. Mild pupillary dilation occurred following this procedure and was associated with apparent histologic damage to the long posterior ciliary nerves. This nerve damage may contribute to the observed reduction in intraocular pressure.

The relationship between blood flow to the ciliary body and intraocular pressure has been of interest for many years. Investigators have interrupted both long posterior arteries in rabbits to assess the effect on intraocular pressure. Interruption of these arteries has produced hypotony, phthisis bulbi, anterior segment necrosis, ruberosis iridis, and cataracts. On the basis of rabbit hypotony, the technique was applied clinically to the treatment of secondary glaucoma. The therapeutic effect has not been satisfactory in human beings. This study was designed to assess species differences in the effect of bilateral long posterior ciliary canal cautery on the intraocular pressure in the primate, Saimiri sciureus, which has a ciliary vascular supply similar to man.

Materials and methods. Nine squirrel monkeys (S. sciureus), weighing 3 to 4 pounds, were anesthetized with ketamine. Intraocular pressures were measured after the instillation of 0.1 per cent proparacaine HCl topical anesthetic by Perkins applanation tonometry. The measurements were obtained on alternate days. After three baseline measurements, a lateral orbitotomy was performed in each eye and Tenon's capsule reflected from the area of the long posterior ciliary canal both medially and laterally. Visualization of the canal at the time of surgery was difficult. Care was taken to not alter the anterior ciliary blood supply by avoiding excessive traction to the delicate horizontal recti muscles.

At eight millimeters posterior to the limbus, underneath each horizontal rectus muscle, four cautery* applications of approximately one second duration each were placed in each of three vertical rows. The contralateral eye served as a control in which the same areas were exposed but were not cauterized.

Intraocular pressures were measured on alternate days for four weeks. The anterior segment and iris were evaluated each time for evidence of abnormality. Prior to death under ketamine and nembutal anesthesia, the animals were anticoagulated with ten thousand units of intravenous heparin. The animals were then killed by intracardiac saline perfusion under a 120 mm. Hg pressure. The right auricle was incised to permit the escape of venous blood. The arterial vascular system was then infused from the heart with a microlatex solution and the eyes were enucleated.

The sclera was cleared with progressively increasing concentrations of glycerine so as to permit visualization of the ciliary blood vessels. The latex was seen in the vessels of the ciliary processes and gave a qualitative measure of filling and patency. The eyes were then fixed in 10 per cent buffered formalin. Sequential coronal sections of the globes through the long ciliary arteries and

*Optemp Ophthalmic Cautery, Alcon Laboratories, Inc. Fort Worth, Texas.
nerves were made to trace their course and to assess thermal damage. Sections were stained with hematoxylin and eosin.

Results. The intraocular pressures fell in both eyes following the surgical procedure, but remained depressed only in the cauterized eye (Fig. 1). The pressure differences between the two eyes are significant from day six to day twenty-four when the animals were killed (Fig. 2).

The appearance of a cauterized site after latex injection and clearing is illustrated in Fig. 3. The latex does not grossly appear to go beyond the point of cauterity. Latex filling of the ciliary body vessels appeared slightly diminished in the cauterized eyes. Histologically, however, the vessels underlying the cauterity are patent, no detectable histologic alteration is present in their walls, and scattered spherules of latex can be seen in the lumen (Fig. 4). The sclera overlying the cauterized canal shows cellular reaction (Fig. 4).

Pupillary dilation and alteration in pupillary response to light were present following cauterity in some of the animals. The long posterior ciliary nerves in the regions of cautery were damaged as evidenced by swollen axons, vacuolated myelin, and intraneural pigment migration (Fig. 4). The
anterior segment was clear and little inflammation was present at the time of death. Histologically, the ciliary bodies appeared normal.

Discussion. The dependence of intraocular pressure on the long posterior ciliary artery circulation has been of considerable interest. Studies have been performed in subprimates to assess the response to cautery or interruption of these vessels on the intraocular pressure. As a model in which to study the effects of long posterior ciliary artery interruption on intraocular pressure, the rabbit is inappropriate because it does not have an anterior ciliary blood supply.

Early experiments in our laboratory on primates revealed persistent lowering of the intraocular pressure in rhesus macaque monkeys following interruption of all the posterior ciliary arteries and nerves about the optic nerve. This has also been noted by Hayreh and Baines to persist for up to three months.

In this study, selective cautery of the long posterior ciliary canals resulted in a lowering of the intraocular pressure in squirrel monkeys. However, localization and obstruction of these vessels was difficult to effect. The long posterior ciliary arteries enter the canals near the optic nerve and are no longer visible as they course through the suprachoroid. Although latex did not grossly appear to pass the area of cautery in many treated vessels, it was not possible to histologically demonstrate damage to or closure of any of these vessels. The closure may have been incomplete or transient. The ciliary bodies appeared histologically normal.

Several factors appear to contribute to the alteration in intraocular pressure observed after long posterior ciliary canal cautery. A large portion of the blood to the ciliary body comes via this route. A significant reduction in blood flow to the ciliary body from the long posterior ciliary route may not be compensated by an increase via the anterior ciliary vessels, resulting in decreased aqueous production.

Damage to the nerve supply in the ciliary canal may be responsible for some of the observed reduction in intraocular pressure. Holland and Mims have observed up to 35 per cent reduction in intraocular pressure following anterior segment chemical sympathectomy in adult owl monkeys. The effect has persisted for up to three weeks. Although a transient increase in facility of outflow was found to occur following sympathectomy, the longer duration pressure lowering effects were attributed to reduced aqueous secretion.
has reported similar observations in a human case of postganglionic Horner’s syndrome.

The clinical application of long posterior ciliary canal cautery has met with equivocal success in the treatment of glaucoma. We have found it clinically ineffective in secondary glaucoma. Histologic sections of two such eyes did not reveal closure of the long posterior ciliary arteries one month after treatment.

From our experimental results it is clear that closure of the long posterior ciliary vessels is difficult to obtain by cautery in primates. This appears due to difficulty in localizing the vessels, their depth in the suprachoroid, and impermanence of vessel closure. The significant reduction of intraocular pressure noted for at least four weeks in this study is believed to be due to a reduction in blood flow to the ciliary body. The extent to which sympathetic denervation contributed to this intraocular pressure lowering effect is under investigation.

We wish to thank Dr. David M. Worthen for many valuable suggestions.

From the Departments of Ophthalmology and Pathology, University of Florida, and the Veteran’s Administration Hospital, Gainesville, Fla. This study was supported in part by a grant from the James Thurber Memorial Fund and Grant G507, both from Fight for Sight, Inc., New York City. Submitted for publication Feb. 20, 1974. Reprint requests: Dr. Norman S. Levy, Chief of Ophthalmology, Veteran’s Administration Hospital, Gainesville, Fla. 32602.

Key words: glaucoma, ciliary body, aqueous humor, long posterior ciliary arteries, long posterior ciliary nerves, primate, saimiri sciureus, squirrel monkey, intraocular pressure.

REFERENCES


The nature of chorioretinal lesions produced by the gallium arsenide laser.

DOLPH O. ADAMS,** D. J. LUND, AND PAUL D. SHAWALUK.

Technical modifications of the gallium arsenide laser have recently permitted its emission of sufficient power to produce ocular damage. The emitted radiation at 8,600 A is in the visible spectrum and, hence, primarily damages the retina. Ophthalmoscopically, the lesions are tertiads of well-defined opacity surrounding small central circles of lesser opacity. The lesions are histopathologically characterized by extensive damage to pigment epithelium and outer retina. The damage is irregular, consisting of extensive damage at the periphery of the burn accompanied by relative sparing of the centers. Furthermore, damaged areas are circular despite an elliptical beam emitted from the laser. The lesions resolve by phagocytic removal of destroyed retina and by reconstitution of pigment epithelium; significant gliosis does not occur. These findings suggest the gallium arsenide laser damages the retina by thermal means, though producing peculiar lesions that are both circular and uneven.

Technical advances have now resulted in development of a gallium arsenide laser which can