

A Comparison of Retinal Argon Laser Lesions in Man and in Cynomolgus Monkey* **

I. H. L. Wallow, O.-E. Lund, and V.-P. Gabel

Augenklinik der Universität München (Direktor: Prof. Dr. O.-E. Lund), München

R. Birngruber and F. Hillenkamp

Gesellschaft für Strahlen- und Umweltforschung m.b.H., Neuherberg b. München

Received November 9, 1973

Summary. Suprathreshold argon laser lesions produced under comparable experimental conditions in man and in cynomolgus monkey showed the same degree of retinal destruction and approximately the same width of retinal damage. Four times the power necessary to produce an ophthalmoscopic threshold lesion was insufficient to inflict damage to the inner retinal half. In therapeutic argon laser photocoagulations, for instance in the treatment of diabetic microaneurysms, this power level should, therefore, be exceeded.

Zusammenfassung. Argonlaserläsionen oberhalb der ophthalmoskopischen Schwelle wurden unter vergleichbaren experimentellen Bedingungen in der Netzhaut eines menschlichen Voluntärs sowie eines Cynomolgusaffen produziert. Die Läsionen zeigten bei histopathologischer Untersuchung den gleichen Grad von Netzhautzerstörung und ungefähr die gleiche Schadensausdehnung. Selbst bei einer Laserleistung, die das Vierfache der zur Erzeugung einer ophthalmoskopischen Schwellenläsion notwendigen Leistung betrug, blieb die innere Netzhauthälfte unversehrt. Wenn Argonlaserkoagulationen z.B. zur Behandlung von diabetischen Mikroaneurysmen eingesetzt werden, sollte dieses Leistungsniveau überschritten werden.

Introduction

Primate monkeys like the rhesus monkey (*macaca mulatta*) and the cynomolgus monkey (*macaca iris*) have become the most widely used experimental animals in investigations studying the effects of laser irradiation to the retina. It is generally accepted that results found in these monkeys provide useful information as to the situation in man. Yet to our knowledge only Vassiliadis *et al.* (1969) have reported a comparison of retinal laser lesions produced in both species under the same experimental conditions using similar laser powers and exposure times.

* Herrn Prof. Dr. H. K. Müller zum 75. Geburtstag gewidmet.

** This investigation was supported in part by grant NT 188 of the Bundesministerium für Forschung und Technologie (vormals Bundesministerium für Bildung und Wissenschaft, Bonn).

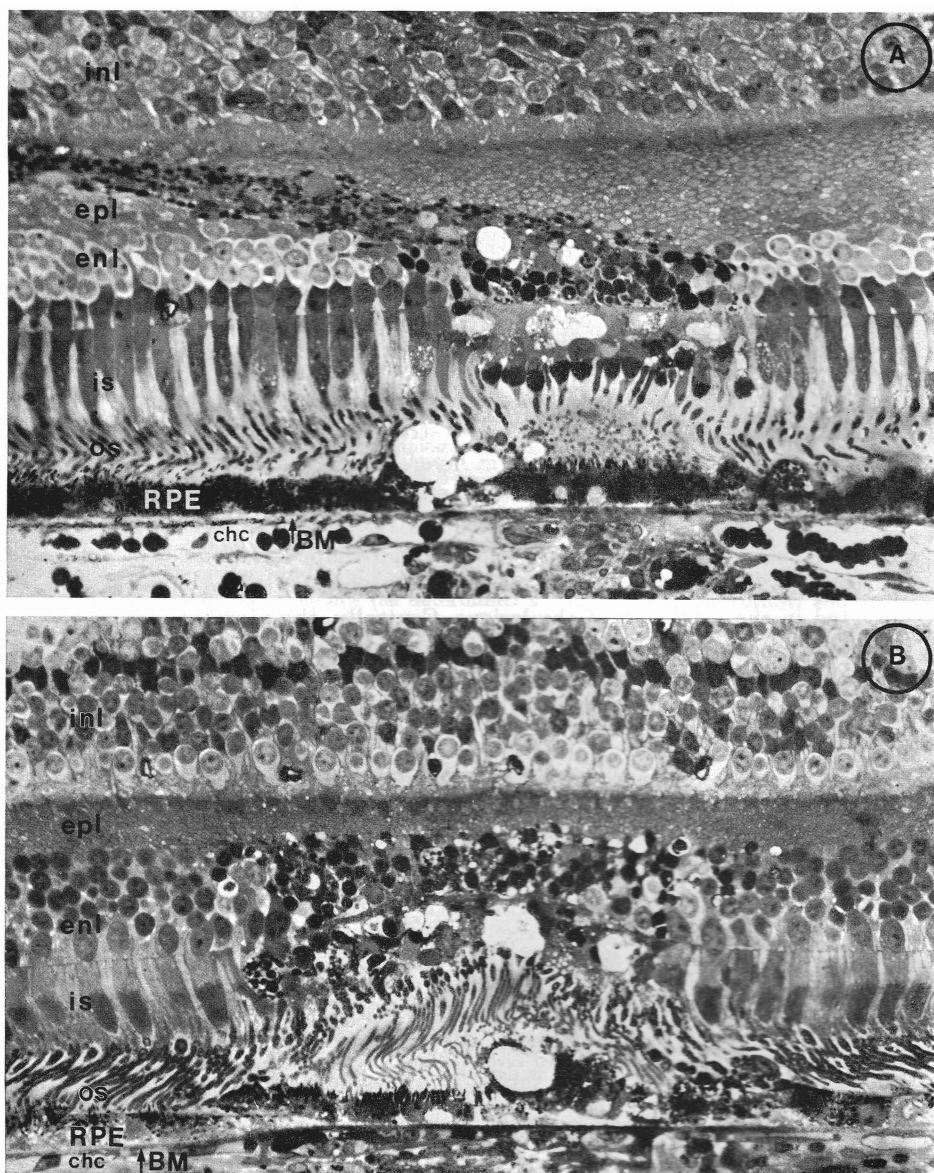


Fig. 1. Light micrographs showing argon laser lesion of the perimacular retina of man (A) and of cynomolgus monkey (B). The lesion in A is 1 day old and was produced with 60 mw at 77 msec. The lesion in B is 2 days old and was produced with 70 mw at 77 msec. A and B Within the lesions, the retinal pigment epithelium (*RPE*) and the photoreceptor cells including outer segments (*os*) inner segments (*is*), nuclei in the external nuclear layer (*enl*), and axons in the "external plexiform layer" (*epl*) are partially vacuolated, partially condensed and hyperchromatic. No damage to the inner nuclear layer (*int*) is present. *BM* Bruch's membrane; *chc* choriocapillaris. In A, damaged photoreceptor cell axons which leave the macula, are cut obliquely. (1.5 μ m Epon section, toluidine blue, A and B $\times 420$)

In both species, the extension of the retinal damage was wider at the level of the retinal pigment epithelium as compared to the level of the external nuclear layer. The widths as measured in the central section through each lesion are given in Table 1.

Comment

Retinal argon laser lesions above the ophthalmoscopic threshold (subsequently also referred to as suprathreshold lesions) were produced in man and in cynomolgus monkey (*macaca iris*), the closest relative of rhesus monkey (*macaca mulatta*), to the perimacular fundus under identical experimental conditions using a similar laser power (60 and 70 mw, respectively, determined at the plane of the cornea) and the same exposure time (77 msec). The retinal image size in man was calculated to be $18\ \mu$ in diameter, in cynomolgus monkey it was estimated to be $16\ \mu$ in diameter. Histopathologically, the lesions showed the same configuration of damage, i.e. they all involved the retinal pigment epithelium (RPE) and the photoreceptor cells including their nuclei within the external nuclear layer (ENL) and their axons. The width of retinal destruction as measured at the RPE-level and at the ENL-level was not significantly different between man and cynomolgus monkey. These data though very limited as yet are taken as an indication that a difference in fundus sensitivity between the two species, if there is any, is rather small at least for minimal spot sizes relatively low laser powers, and exposure durations within the range of the blinking reflex. This result is compatible with observations by Vassiliadis *et al.* (1969) made in two human volunteers and in rhesus monkey under somewhat different experimental conditions. More data based on human volunteers with an intact ocular fundus at the posterior pole are required to arrive at more definite conclusions.

When compared to ophthalmoscopic threshold lesions which we have produced in cynomolgus monkeys for other purposes (Birngruber *et al.*, 1972), the total power for the suprathreshold lesions described in this report was approximately four times higher. The ophthalmoscopic threshold lesions typically showed a destruction of the outer retinal half, extending over an area of approximately $60\text{--}80\ \mu\text{m}$ in diameter at the RPE-level and of $30\text{--}40\ \mu\text{m}$ in diameter at the ENL-level (Wallow *et al.*, 1973, in press). Interestingly, the present suprathreshold lesions exhibited the same pattern of damage and differed merely in width of retinal damage (approximately $190\ \mu\text{m}$ at the RPE-level and $150\ \mu\text{m}$ at the ENL-level); the inner retinal half internal to the middle limiting membrane still remained uninvolved.

It is tempting to apply the ratio of 4 to the relationship between ophthalmoscopic threshold lesions and suprathreshold lesions in man.

In man, the argon laser is now frequently employed in the therapy of retinal diseases, for instance in order to destroy leaking microaneurysms in background diabetic retinopathy. These aneurysms are almost always located within the inner retinal half with only few aneurysms bulging outward into the outer plexiform layer. Threshold lesions just visible ophthalmoscopically, as well as lesions produced with a laser power four times above that for such threshold lesions would then not suffice to destroy microaneurysms.

References

- Birngruber, R., Wallow, I. H. L., Gabel, V.-P., Hillenkamp, F., Schmidt, R.: Zur Bestimmung der Schädigungsschwellenwerte der Netzhaut durch Laserstrahlen. Gesprächskreis: Laseranwendung in der Ophthalmologie anlässlich der 72. Tagung der Deutschen Ophthalmologischen Gesellschaft in Hamburg, 23. 9. 1972
- L'Esperance, F. A., Kelly, G. R.: The threshold of the retina to damage by argon laser radiation. *Arch. Ophthalm.* **81**, 583-588 (1969)
- Vassiliadis, A., Rosan, R. C., Zweng, H. C.: Research on ocular laser threshold. Stanford Research Institute, Menlo Park, Calif.; Final Report, August 1969
- Wallow, I. H. L.: Netzhautreaktionen nach Intensivlichtbestrahlung. Experimentelle, morphologische und klinische Untersuchungen über pathologische und therapeutische Wirkungen von Laserlicht und von weißem Licht. Habilitationsschrift (medical thesis), Med. Fakultät d. Ludwig-Maximilians-Universität, München, 1973
- Wallow, I. H. L., Gabel, V.-P., Birngruber, R., Hillenkamp, F.: Klinische und histologische Untersuchungen nach Argonlasereinwirkung auf die Netzhaut.— Die histopathologische Auswertung von Laserläsionen als Mittel zur Abschätzung einer funktionellen Laserschädigungsschwelle. *Ber. dtsch. ophthal. Ges.* **73** (1974), in press

Dr. Ingolf H. L. Wallow
Univ.-Augenklinik
D-8000 München 2
Mathildenstraße 8
Federal Republic of Germany