Pigmented lens striae

GEORGE D. STURROCK AND RAMESH C. TRIPATHI

*From Moorfields Eye Hospital and the Department of Pathology,
Institute of Ophthalmology (University of London), Judd Street, London*

In his atlas of slit-lamp microscopy of the eye Vogt (1931) described an unusual condition of fine brown radial lines on the anterior lens capsule in the mid-periphery behind the iris. Because pupillary membrane remnants were present in three patients he concluded that the striae represented persistent tunica vasculosa lentis—a view supported by Lugli (1933), Streiff (1935), Bischler (1939), Vogt (1942), and Bellows (1944) when reporting further examples of this condition. Cowan (1961), however, suggested that some cases of 'retroiridic lines' might represent congenital deposition of pigment on zonular fibres. In the absence of any histological study, the precise nature of the pigmented lens striae remained unresolved.

During the past two years one of us (GDS) saw a number of patients with these pigmented lens striae. Since their morphology and distribution seemed inconsistent with a diagnosis of persistent tunica vasculosa lentis we examined three of the lenses by electron microscopy. This paper correlates for the first time the clinical with the ultrastructural features of pigmented lens striae.

Patients and methods

Pigmented striae on the anterior lens capsule were seen in six women and one man aged between 51 and 87 years. Two of the patients had chronic glaucoma, one had a retinal hole, and four were in hospital for cataract surgery. The lenses from three of the patients with cataracts were processed for examination by electron microscopy.

In the first patient chymotrypsin was used to dissolve the zonule before removal of the lens. The lenses of the other two patients were extracted without the use of this enzyme. The lens in one case was delivered with capsule forceps, taking care to grasp the capsule some distance away from the previously determined position of the pigmented striae. In the third patient the lens was removed with a cryoprobe, purposely freezing on to the capsule at the site where striae had been noted preoperatively.

The extracted lenses were fixed immediately in

isotonic buffered glutaraldehyde (2.5 per cent solution). The pigmented striae were identified under a dissecting microscope, tissue blocks were postfixed in 1 per cent buffered osmium tetroxide solution and, after dehydration, were finally embedded in Araldite. Using glass knives, sections were cut on an LKB Ultratome III at about right-angles to the long axis of the striae. Thin sections were stained with uranyl acetate and lead citrate and micrographs were taken with a JOEL 100C electron microscope.

Results

In all seven patients the pigmented striae could be seen only when the pupil was dilated. They were situated on the anterior lens capsule in the mid-periphery, predominantly on the nasal side (Fig. 1). Although arranged in a basically radial manner, some striae forked at an acute angle (Fig. 2). The number of striae visible varied from only three or four in some patients to several dozen in others. Individual striae appeared as very fine straight lines of uniform width a millimetre or more in length. In two patients with pigment speckling of the anterior lens capsule some striae had a beaded appearance due to small deposits of pigmented particles. Most striae were dark brown in colour in focal illumination, although in one patient fine translucent grey striae were also visible.

The three extracted lenses were examined under a dissecting microscope. No striae could be found on the lens which was extracted after irrigation of the posterior chamber with chymotrypsin. Striae were seen, however, on the two lenses removed without the use of chymotrypsin (Fig. 3).

Analysis by electron microscopy showed that the pigmented striae consisted of variable-sized, electron-dense, round or oval granules entrapped in bundles of fine fibrils. Sections along the length of the striae showed that near their termination the fibrillar bundles were in close contact with the lens capsule (Fig. 4) whereas peripherally they were separated from the surface of the lens capsule (Fig. 5). The fibrillar bundles were composed of numerous fine filamentous structures cut transversely or obliquely; the individual fibrils varied from 12–15 nm in diameter and had a faint axial

FIG. 1 *Painting to show radial disposition of pigmented striae on mid-periphery of anterior lens capsule. Pigment speckling also visible in same region. Right eye of woman aged 70 with chronic simple glaucoma and shallow anterior chamber*

periodicity of 20–25 nm (Fig. 6). The electron-dense pigment granules were irregularly dispersed along the fibrillar bundles, and at higher magnification appeared to consist of finely particulate or amorphous material and occasional granules showed fibrillar profiles (Fig. 6). No cell organelles were seen in relation to these granules.

Discussion

A review of the 70 reported cases of pigmented lens striae shows that they occurred most often in middle-aged and elderly patients, of whom 80 per cent were women. Except for a girl aged 17 (Vogt, 1942) and a young man of 27 (Bellows, 1944), the 70 patients were aged between 40 and 87 years. The striae were bilateral in over half the cases, although more pronounced in one eye. Most authors have commented on the predominantly nasal disposition of the striae, which remains unexplained.

The older-age incidence of pigmented lens striae strongly suggests that the pigmentation is acquired, the most likely source being the pigment layer of the iris. In support of this is the observation that when the pupil can be dilated sufficiently pigmented lines are often seen to terminate before

reaching the extreme periphery of the lens, which, owing to its backward curvature, is not usually in contact with the iris. Examination of the lens in four patients with congenital aniridia showed no sign of pigmented lens striae (Iwaszkiewicz-Bilikiewiczowa and Janukowiczowa, 1969).

In many of the reported cases of pigmented lens striae there was evidence of generalized pigment dispersion in the anterior segment. Lugli (1933) mentioned pigment deposition on Descemet's membrane in a patient with iris atrophy and pigmented lens striae, and Bischler (1939) described pseudoexfoliation (commonly associated with pigment dispersion) in one patient with pigmented lens striae and a Krukenberg spindle in a second patient. Stankovic and Stankovic (1962) noted much pigmentation of the trabecular meshwork and raised intraocular pressure (without field loss) in nine out of 14 patients with pigmented lens striae, none of whom had pseudoexfoliation or a Krukenberg spindle.

The illustrations of Vogt (1931) of pigmented lens striae also show non-pigmented, greyish translucent striae in some of his patients. Similar non-pigmented striae were described by Lugli (1933), Bischler (1939), Bellows (1944), and Berliner (1949) in patients with pigmented lens striae, and

they were also seen in one of the seven patients presented here. These grey striae resemble the condition called *Strahlenkranztrübung* originally described in glass-workers by Schläpfer (1930) and Vogt (1931). Subsequently Abramowicz (1933) and Bücklers (1939) found the same condition in a high proportion (90 per cent and 72 per cent respectively) of patients not engaged in glassmaking or foundry work.

The grey striae of *Strahlenkranztrübung* are not visible in the zone of specular reflection from the anterior surface of the lens, and were therefore assumed to be subcapsular by Vogt (1931), Abramowicz (1933), and Bücklers (1939), who did not relate them to pigmented lens striae. Abramowicz (1933), however, found pigmented lens striae associated with grey striae in one patient and in another noted that an incomplete ring of grey striae, concentric with the pupil, was interrupted only at the site of an iridectomy performed 13 years previously for glaucoma. Bischler (1939) recorded the almost total disappearance of bilateral lens striae, some grey-blue and some pigmented, after bilateral iridencleisis procedures performed in a woman of 66. In both of these patients intra-ocular surgery may have disturbed their lens striae, suggesting that the non-pigmented striae were, like the pigmented lens striae, situated on the surface of the capsule. Bischler also described the spontaneous disappearance of well-marked pigmented lens striae 15 months after they were first observed in a woman of 45 who presented with presbyopia. Possibly, therefore, the grey striae of *Strahlenkranztrübung* are similar in nature to the non-pigmented striae sometimes associated with pigmented lens striae.

Electron microscopical analysis clearly shows that pigmented lens striae are formed by pigment granules trapped within the fibrillar bundles of the zonules. The absence of any other cellular components associated with the pigment granules suggests that they entered the zonular bundles as free-floating pigment and were probably not deposited by wandering cells or elaborated locally. The morphological appearance of the granules seems consistent with an origin from the uveal tract, the pigment layer of the iris being the most likely source (Feeney, Grieshaber, and Hogan, 1965).

Pigmented lens striae can be differentiated clinically from conditions such as 'persistent pupillary membrane', posterior synechiae showing as pigmented streaks after mydriasis, and pseudo-exfoliation associated with pigment dispersion. The mesodermal strands of a 'persistent pupillary membrane' are much coarser than pigmented lens striae and rarely have a strictly radial orientation. The strands, which may be multiple to form a net-

FIG. 2 Slit-lamp photograph of pigmented lens striae near margin of dilated pupil (white zone). Note acute forking of some striae. Left eye with retinal hole of man aged 66. ($\approx \times 80$)

FIG. 3 Macro photograph of extracted lens showing pigmented stria which forks (arrow) at insertion into anterior lens capsule. Epithelial cells and lens fibres visible in the background. ($\approx \times 70$)

like pattern, are almost invariably attached to the iris collarette. Mydriasis commonly alters the disposition of pupillary strands since they are usually distensible and stretch with the pupil. Pupillary strands may coexist with pigmented

FIG. 4 *Electron micrograph of pigmented lens stria in section near attachment to lens capsule (LC). Stria consists of fine fibrils (cut transversely and obliquely) with characteristics of fibrils of zonular bundles. P=trapped pigment granules. (Fixed GA/OsO₄, stained UA/LC. $\times 60\ 000$)*

FIG. 5 Electron micrograph of pigmented lens stria in section at region peripheral to attachment showing spatial relationship of stria with lens capsule (LC). Note numerous pigment granules (P) entrapped by the fibrillar component of the stria. (Fixed GA/OsO₄, stained UA/LC. $\times 22\ 800$)

FIG. 6 Higher magnification of pigmented lens stria in section. Note some variation in morphology of pigment granules (P) and characteristic fine fibrils of zonule. Variable orientation of fibrils probably due to relaxed state of the bundle. (Fixed GA/OsO₄, stained UA/LC. $\times 67\,500$)

lens striae as in three of Vogt's cases (Vogt, 1931).

The pigmented streaks of posterior synechiae are situated more centrally on the lens than pigmented lens striae and are attached to the pupil margin. They are also much broader than striae and their postinflammatory origin is usually evident.

The diagnosis of pseudoexfoliation is suggested by the presence of blue-grey floccules on the pupil margin and confirmed by dilating the pupil to reveal the characteristic peeling sheets of pseudoexfoliative material on the lens surface with an annular clear zone corresponding to the resting position of the pupil. Pseudoexfoliation may also coexist with pigmented lens striae (Bischler, 1939). Ultrastructurally there is little doubt that the fine fibrillar bundles analysed in specimens belong to the zonular system (Hogan, Alvarado, and Weddel, 1971; Raviola, 1971; Takei and Ozanics, 1975), and they could be differentiated from the coarse and haphazardly arranged collagenous fibrils of pupillary membranes (Matsuo and Smelser, 1971). Pigmentation of zonular fibres on the anterior lens

capsule renders them visible with the biomicroscope and also shows that some fibres are inserted more centrally on the anterior lens capsule than is commonly described (Duke-Elder, 1961).

Summary

The clinical features of pigmented lens striae were studied biomicroscopically in seven patients. The lenses of three of these, obtained by cataract surgery, were examined by electron microscopy to determine the structure of the striae. We concluded that the striae are not formed by remnants of tunica vasculosa lentis, as earlier workers believed, but consist of fine fibrils of zonular bundles entrapping pigment granules of uveal origin.

We thank Professor N. Ashton, FRS, Mr D. Greaves, FRCS, and Mr. R. J. H. Smith, FRCS, for their encouragement and Mr R. Howes for his technical assistance. This work was supported in part by the locally organized clinical research scheme of Moorfields Eye Hospital.

References

- ABRAMOWICZ, I. (1933) *Ann. Oculist. (Paris)*, **95**, 602
 BELLOWS, J. G. (1944) *Arch. Ophthalm.*, **32**, 483
 BERLINER, M. L. (1949) 'Biomicroscopy of the Eye', vol. 2. Hoeber, New York
 BISCHLER, V. (1939) *Klin. Mbl. Augenheilk.*, **103**, 517
 BÜCKLERS, M. (1939) *Ibid.*, **103**, 413
 COWAN, T. H. (1961) *Surv. Ophthalm.*, **6**, 630
 DUKE-ELDER, S. (1961) 'System of Ophthalmology', vol. 2, p. 335. Kimpton, London
 FEENEY, L., GRIESHABER, J., and HOGAN, M. J. (1965) 'Studies on Human Ocular Pigment', Eye Structure Symposium II, ed. J. W. Rohen, pp. 535-548. Schattauer, Stuttgart
 HOGAN, M. J., ALVARADO, J. A., and WEDDEL, J. E. (1971) 'Histology of the Human Eye'. Saunders, Philadelphia, London, Toronto
 IWASZKIEWICZ-BILIKIEWICZOWA, B., and JANUKOWICZOWA, H. (1969) *Klin. oczna*, **39**, 693
 LUGLI, L. (1933) *Rass. ital. Ottal.*, **2**, 1334
 MATSUO, N., and SMELSER, G. (1971) *Invest. Ophthalm.*, **10**, 108
 RAVIOLA, G. (1971) *Ibid.*, **10**, 851
 SCHLÄPFER, H. (1930) *Klin. Mbl. Augenheilk.*, **85**, 285
 STANKOVIC, M., and STANKOVIC, I. (1962) *Bull. Soc. franç. Ophtal.*, **75**, 586
 STREIFF, E. B. (1935) Indagine biomicroscopica sui residui delle tunica vascolare retroiridea del cristallino. Atti del XXXIII congr. della Soc. Oftal. Ital., p. 89.
 TAKEI, Y., and OZANICS, V. (1975) *Jap. J. Ophthalm.*, **19**, 69
 VOGT, A. (1931) 'Lehrbuch u. Atlas der Spaltlampenmikroskopie des lebenden Auges', vol. 2, 2nd ed. Springer, Berlin
 — (1942) 'Lehrbuch u. Atlas der Spaltlampenmikroskopie des lebenden Auges', vol. 3, 2nd ed. Enke, Stuttgart