IRIDOSCHISIS*†

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SCHMITT (1922) was the first to describe a condition in which the iris stroma was split meridionally into two layers. The fibres of the anterior layer were ruptured and the unattached ends of these fibres floated free in the aqueous. Further cases were subsequently recorded by Drapkin (1923), Sander (1925), Vogt (1926), Schoenberg (1927), Imre (1927), and Dollfus (1927). Loewenstein and Foster (1945) presented the first histopathological study in describing one further case and proposed that the condition be termed "iridoschisis". Other examples of iridoschisis have since been described by Loewenstein, Foster, and Sledge (1948), Linn and Linn (1949), Garden and Wear (1949), McCulloch (1950), Blegvad (1951), Haik, Lyda, and Waugh (1952), Carter (1953), and Winstanley (1961). Seventeen cases have been traced in the literature, many in association with glaucoma (Table, overleaf). In others it was observed following trauma or chronic iridocyclitis. In several senile patients, apart from cataract, no associated ocular disease was evident.

Four further examples of iridoschisis are described in the present communication, and the aetiology of the condition is discussed with particular reference to its association with glaucoma.

Methods

(1) *Tonometry*.—Except where stated in the case histories, the intra-ocular pressures were estimated by a weighted Schiötz tonometer.

(2) *Tonography*.— P_0 was determined by a Goldmann applanation tonometer affixed to a Haag-Streit "900" slit lamp. P_{t1} and P_{t2} were determined at the beginning and end of a 4-minute period by direct scale readings taken from a Schwartz electro-tonometer. No continuous recording device was available. The co-efficient of outflow (C) was determined by graphical construction, using a nomogram (Friedenwald, 1957) with correction for ocular rigidity. P_0/C values were then calculated.

Case Reports

Case 1, a boy aged 11 years, was struck in the left eye by a splinter of wood while chopping sticks on May 5, 1962. On examination a sectoral schisis of the left iris stroma was present inferiorly (Figure). The anterior lamina of iris had gravitated into the angle of the anterior chamber, but was still attached at the iris root. A corneal abrasion was present, and slit-lamp examination revealed a flare and cells (+ +). The fundus was normal, and no intra-orbital foreign body was seen on x ray. The uveitis rapidly resolved using atropine and chloramphenicol drops and oral penicillin V. When last seen on August 8, 1962, the zone of iridoschisis showed no change, and

* Received for publication October 14, 1965.

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FIGURE.—Iris diagrams, Cases 1–4. Stippled areas indicate the extent of the iridoschisis.

the visual acuity (uncorrected) was 6/5 in the right eye and 6/6 in the left. The iris of the right eye was normal.

Case 2, a man aged 48 years, presented on February 8, 1960, with a mild acid burn of the left eye. The superficial layers of the left iris were noted to be “torn”. He had sustained a right detached retina in 1934, when he was a professional boxer; an operation to re-attach the retina had failed, and the right eye was subsequently enucleated and a prosthesis fitted.

The patient attended again in September, 1963, with a chalazion of the right upper lid. Two adjacent zones of iridoschisis were present infero-temporally in the left eye (Figure), which was otherwise normal, the visual acuity being 6/6 (corrected with -0.5 D sph., $+0.5$ D cyl., axis 120°) and the intra-ocular pressure 17.5 mm. Hg.

Case 3, a woman aged 65 years, was first seen on July 21, 1961, having suddenly developed pain and mistiness affecting the right eye while in hospital immediately following hysterectomy. The right eye showed circumcorneal and conjunctival injection, corneal oedema, a fixed dilated pupil, and a high (+++) intra-ocular pressure. The left eye was normal apart from a shallow anterior chamber. A diagnosis of right acute closed-angle glaucoma was made. She had had no prodromal symptoms and there was no history of trauma. The right intra-ocular pressure was reduced to normal with gutt. eserine 1 per cent., gutt. pilocarpine 2 per cent., and oral Diamox. The eserine was discontinued after 2 days and the Diamox after 5 days. The patient was discharged from hospital on August 2, 1961, using gutt. pilocarpine 1 per cent. twice daily to both eyes.

On September 15, 1961, an atrophic area was noted in the medial part of the right iris. The intra-ocular pressures were normal digitally and the visual acuity (corrected) was 6/12 in the right eye and 6/18 in the left.

On December 12, 1961, iridoschisis of the right iris was observed in the previously atrophic area (Figure). Gonioscopy revealed narrow open angles in both eyes. A right peripheral

TABLE
 PARTICULARS OF SEVENTEEN CASES OF

Author(s)	Date	Case Report No.	Sex	Age (Yrs)	Affected Eye(s)	History of Ocular Trauma	Signs of Glaucoma
Schmitt	1922	i	F	74	Right	No	No
Drapkin	1923	ii	F	74	Right and Left	No	No
Sander	1925	iii	M	78	Right	No	No
Vogt	1926	iv	F	70	?	No	No
Schoenberg	1927	v	M	51	Left	Yes	Yes
Imre	1927	vi	?	92	?	No	No
		vii	?	94	?	No	No
Dollfus	1927	viii	F	?	Right and Left	No	No
Loewenstein and Foster	1945	ix	F	76	Right and Left	No	Yes
Loewenstein, Foster, and Sledge	1948	x	M	46	Right	Yes	Yes
Linn and Linn	1949	xi	M	58	Right	No	Yes
Rohm	1949	xii	F	82	Right and Left	No	Yes
Garden and Wear	1949	xiii	M	75	Right	No	Yes
McCulloch	1950	xiv	F	56	Right and Left	No	Yes
Blegvad	1951	xv	F	62	Left	No	No
Haik, Lyda, and Waugh	1952	xvi	M	67	Right and Left	No	Yes
Carter	1953	xvii	F	76	Right and Left	Yes	Yes

iridectomy was performed in May, 1962, and a left peripheral iridectomy in June, 1962, the pilocarpine drops being discontinued. No post-operative complications occurred. The intra-ocular pressures have remained normal. Nuclear sclerosis of the lenses was noted in July, 1963, and when the patient was last seen on October 2, 1964, the visual acuity (corrected) was 6/18 in each eye. No central field defect was present (Bjerrum screen) though the right optic disc appeared to show slight pathological cupping. The left optic disc was normal. The intra-ocular pressures were 14 mm. Hg in the right eye and 15 in the left (Goldmann applanation tonometer), and the co-efficients of outflow were 0.32 (P_0/C 44) in the right eye and 0.24 (P_0/C 63) in the left. The right iridoschisis had shown no progression and the angle of the anterior chamber was open all round. Only one fine fibre of the schisis reached into the angle. The pupillary sphincter was intact and

IRIDOSCHISIS REPORTED IN THE LITERATURE

Other disease of affected eye(s)	Facts consistent with diagnosis of closed-angle glaucoma
Cataract	Nil
Cataracts	Nil
Cataracts	Nil
Chronic iridocyclitis	Nil
Large peripheral patch of chorio-retinal atrophy	Blue rings around lights occasionally for 1½ years prior to trauma
?	Nil
?	Nil
Cataracts	Nil
Cataracts Bilateral senile macular degeneration ? Old bilateral iritis	Bilateral broad basal iridectomy for glaucoma in 1928 Optic discs and ocular tensions (Schiötz) normal in 1940
Corneal endothelium slightly opaque in pupillary area	Raised ocular tension (Schiötz) controlled by basal iridectomy
Endothelial corneal dystrophy Cataract Pigment deposits in retina	Right angle closed by peripheral anterior synechiae after trephine Left angle open only in small area of nasal portion (unoperated)
Cataracts	Diagnosed as "bilateral narrow-angle glaucoma"
Cataract developed subsequently	Marked asymmetry in degree of glaucoma affecting the two eyes
Searching nystagmus Cataracts Vitreous opacities Pigmentation of fundi ("choroidoschisis")	(Glaucomato-cyclitic crises.—See Discussion)
Conjunctivitis	Nil
Bilateral chronic conjunctivitis Cataracts	Narrow angles in both eyes
Nil	Occasional pain in each eye Very acute angles Bilateral positive mydriatic provocative tests

functional in all sectors. The left iris showed one area on the pupillary margin where the stromal fibres were unusually segregated, giving a spongy appearance. None of the involved fibres was ruptured.

Case 4, a woman aged 75 years, presented on December 11, 1953, complaining of intermittent pain and mistiness affecting the left eye for one month. There was no history of trauma. The left eye showed slight circumcorneal injection, corneal oedema, a semi-dilated fixed pupil, and a high (+ + +) intra-ocular pressure. A diagnosis of left acute closed-angle glaucoma was made. The right eye appeared normal, though the anterior chamber was shallow. The intra-ocular pressures were 35 mm. Hg in the right eye and 63 in the left. The intra-ocular pressures were reduced to normal with oily 1 per cent. eserine drops, and a left trephine was performed 7 days later. No

post-operative complications occurred. Aqueous 1 per cent. eserine drops were prescribed to the right eye only. The visual acuity was then 6/9 in each eye. No cupping of the optic discs was present and a good left subconjunctival drainage bleb was obtained. The central fields were normal in 1954 (Bjerrum screen). Nuclear lens opacities subsequently developed, and the visual acuity in both eyes deteriorated.

Left iridoschisis was first noted infero-nasally in October, 1964 (Figure). The pupillary sphincter was intact and functional in all sectors. A few filaments of the iris stroma were in contact with the corneal endothelium, though none extended into the angle of the anterior chamber. One peripheral anterior synechia was present adjacent to the left peripheral iridectomy. Otherwise the angles of both eyes were moderately narrow but open all round. The intra-ocular pressures were 16 mm. Hg in the right eye and 14 in the left (Goldmann applanation tonometer) and the coefficients of outflow were 0.16 (P_0/C 100) in the right eye and 0.29 (P_0/C 48) in the left. The right co-efficient of outflow was not reliable because of poor fixation with the left eye, the visual acuity being 6/24 in the right eye and hand movements (unaided) in the left. The right optic disc appeared normal. The left optic disc was not visible but the left visual field showed gross peripheral constriction (to confrontation). The patient failed to attend for detailed re-examination of the visual fields. The right iris was normal apart from moderate loss of pigment at the pupillary margin. Miotic therapy was used continuously to the right eye from December, 1953, and to the left eye from February, 1955. Between February, 1955, and March, 1962, gutt. pilocarpine 2 per cent. was prescribed four times daily to each eye. Since March, 1962, gutt. carbachol 0.75 per cent. has been prescribed twice daily to each eye.

Discussion

Carter (1953) noted that approximately half of the cases of iridoschisis described in the literature were associated with glaucoma. In most of the remaining cases the iridoschisis had occurred in senile non-glaucomatous eyes. Vogt (1926) described the changes of iridoschisis in a woman suffering from chronic iridocyclitis. Schoenberg (1927) reported its occurrence in a man who presented after a dive into water from a height of 104 feet and considered that the condition was due to trauma, but the patient also had chronic glaucoma with deep cupping to the optic disc. Loewenstein, Foster, and Sledge (1948) described a patient who presented with iridoschisis 2 years after he had sustained a "black eye", but in this case also the intra-ocular pressure was raised.

Case 1 in the present series is the first to be reported in which iridoschisis definitely occurred as the result of a direct, non-penetrating injury to a normal eye. It seems reasonable to assume that the changes observed in Case 2 were also the result of ocular trauma sustained while boxing.

In Cases 3 and 4 the iridoschisis was associated with primary closed-angle glaucoma. In both patients an episode of acute glaucoma had preceded the development of the iridic change and gonioscopy clearly showed that the fibres of the schisis did not obstruct the angle. In neither case did the schisis extend to the iris root.

In describing one case of iridoschisis associated with glaucoma, McCulloch (1950) suggested that the rise in intra-ocular pressure was caused by the iridoschisis or similar hypothetical changes in the ciliary body. The chronological development of the abnormalities observed in Cases 3 and 4 indicate that, if a causal relationship exists, the schisis is secondary to the glaucoma. It has been noted in all cases of iridoschisis examined gonioscopically that the angle of the anterior chamber was not obstructed by iris fibres or debris (McCulloch, 1950; Haik, Lyda, and Waugh, 1952; Carter, 1953; Cases 3 and 4 above). In the patient described by Linn and Linn (1949), the angle of the affected eye was completely closed by peripheral anterior synechiae *after a trephine operation*, but the fibres of the iridoschisis were quite distinct from the synechiae.

The avascular necrosis of the iris which may occur in closed-angle glaucoma (Winstanley,

1961) might predispose to iridoschisis. Winstanley reported that biomicroscopically the first change appeared to be an acute necrosis of a sector of the iris sphincter muscle. But in Cases 3 and 4 above it was particularly noted that the pupillary sphincter was intact and functional in all sectors. The rare preservation of the pupillary sphincter in an iris sustaining avascular necrosis could be the factor leading to the rupture of the atrophic fibres (Haik, Lyda, and Waugh, 1952). Such a mechanism would be favoured by the use of miotic drugs (Garden and Wear, 1949).

These observations also suggest that the relationship between glaucoma and iridoschisis might be specific to primary closed-angle glaucoma. In many of the recorded cases the nature of the glaucoma is not clear, or the evidence on which the diagnosis was based is not given. The Table summarizes all the cases of iridoschisis that have been traced in the literature and facts consistent with a diagnosis of closed-angle glaucoma are given in the final column. In every case associated with raised ocular tension, other than that of McCulloch (1950), some presumptive evidence of closed-angle glaucoma may be found. The patients described as having iridoschisis by Winstanley (1961) have been omitted from the Table as none was characterized by the rupture of the fibres of the anterior layer of the iris. Without this feature it would seem impossible to distinguish iridoschisis from certain other types of acquired iris atrophy or congenital stromal defect.

McCulloch (1950) considered that his patient suffered from glaucomato-cyclitic crises (Posner and Schlossman, 1948) and his detailed clinical description is entirely consistent with that diagnosis. He noted that the pupillary sphincter of the glaucomatous eye was intact and functional. Of the nine patients with glaucomato-cyclitic crises originally described by Posner and Schlossman (1948), three had heterochromia iridis, the affected eyes being the less pigmented. Thus in McCulloch's patient the combination of glaucomatous iris atrophy and an intact pupillary sphincter could have resulted from acute secondary glaucoma with the subsequent development of iridoschisis.

It is concluded that glaucoma results in iridoschisis only if the glaucomatous disease causes atrophy of the iris. The presence of a functional pupillary sphincter favours the progression from iris atrophy to iridoschisis, though is not essential to it, since in the patient described by Loewenstein and Foster (1945) the pupil was adherent to the lens by posterior synechiae. The factors favouring the development of iridoschisis occur most frequently in primary closed-angle glaucoma, but they are not specific to that disease. It should be noted that these factors would not be expected to occur in uncomplicated chronic simple glaucoma.

The Table indicates that the degenerative change in the iris predisposing to iridoschisis may also be the result of chronic iridocyclitis (Vogt, 1926) or senile iris atrophy (Schmitt, 1922; Drapkin, 1923; Sander, 1925; Imre, 1927; Dollfus, 1927; Blegvad, 1951).

Summary

- (1) Four cases of iridoschisis are described.
- (2) The literature is reviewed, and the aetiology and pathogenesis of iridoschisis are discussed.
- (3) Evidence is presented indicating that when glaucoma and iridoschisis occur in the same eye, the iridoschisis is secondary to the glaucoma. In the majority of these cases the glaucoma is of the primary closed-angle type.

I wish to thank Messrs. C. A. Brown, N. L. Dallas, and A. Stanworth for permission to publish details of their patients.

ADDENDUM

Since this paper was submitted the author has become aware of several further reports of iridoschisis through the references given by Payne and Thomas (1966).

It is noted that Törnquist and Swegmark (1961) recorded one case in which iridoschisis *secondary to severe iritis* probably existed before the onset of glaucoma in the affected eye.

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