

ANGLE VESSELS IN NORMAL EYES A GONIOSCOPIC EVALUATION AND ANATOMIC CORRELATION*†

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NUMEROUS text-books and articles have been written on the subject of gonioscopy, and one would imagine that the visible structures of angle of the anterior chamber would be fully described. The appearance of blood vessels in the angle has, however, aroused little interest except for an article by Chatterjee (1960). It is interesting that much has been written about "abnormal" angle vessels in various ocular disorders or malformations without reference to what might possibly be normal, but in order to discuss abnormal vasculature of the angle one must know the variations of the normal.

This paper deals with the gonioscopic findings in a series of normal eyes. The relationship of iris colour and depth of the angle of anterior chamber to the visibility of angle vessels is described, and an anatomic correlation is attempted.

Material

More than 200 consecutive new clinic patients were examined with the gonioscope in a 3-month period. Of these, 142 patients aged from 11 to 90 years were found to have either one or both eyes free from ocular disease (other than refractive errors or senile changes). 21 patients were negroid. Included in this study are 269 normal eyes, 86 blue, ranging in colour from light blue to grey, and 183 brown ranging, from hazel to dark brown.

Method

Gonioscopy was performed with three-mirrored Goldmann lens and the light source and magnification of either the Haag-Streit or Zeiss slit-lamp biomicroscope. No miotics or mydriatics were instilled before the examination. Both wide and narrow slits of light were used. Occasionally the wide beam caused a miosis that appeared sufficient to pull the last roll of the iris away from the angle and thus allow a view of vessels not seen by examination with the narrow slit alone.

The angle was graded as wide, medium, or narrow:

Wide.—The greater part of the ciliary band was seen;

Medium.—The entire trabecular zone and possibly a portion of the ciliary body were seen;

Narrow.—Only a small portion of the trabecular zone was seen.

[It is interesting to note that the iris in apparently blue-eyed individuals may appear darker, even brownish, when observed at the viewing angle provided by the gonio-lens.]

The histological sections used herein are not taken from any of the patients studied gonioscopically. They are from eyes enucleated for various reasons (as described in the captions to illustrations), in which there was no clinical history of anterior chamber disease. The sections illustrated were either vertical or horizontal through the optic nerve and the centre of the cornea.

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Results (Table)

Gonioscopically visible vessels were noted in the angle of seventy of the 269 normal eyes (26 per cent.). They were seen in 53 of the 86 blue eyes (62 per cent.), but in only seventeen of the 183 brown eyes (9 per cent.). They were more commonly seen in eyes with wide angles (32 out of 47 (58 per cent.) blue eyes; 12 out of 87 (14 per cent.) brown eyes) than in those with medium or narrow angles. In seventeen patients vessels were noted bilaterally. Not one of the 21 Negro patients had gonioscopically visible vessels, though more than half had wide angles. Vessels were more frequently noted in the lower angle, probably because of the greater gonioscopic visibility. No sex or age differences were noted.

TABLE
GONIOSCOPIC EVALUATION OF VESSELS SEEN IN 269 NORMAL EYES

Colour of Eyes	Width of Angle	No Vessels	Type of Vessel			
			CCB	RI	CCB + RI	RCB-Tr
Blue	Wide	15	7	7	17	(6) + 1
	Medium	17	5	7	8	(2)
	Narrow	—	—	—	2	—
	Total	32	12	14	27	(8) + 1
Brown	Wide	75	9	3	—	—
	Medium	82	5	—	—	(1)
	Narrow	9	—	—	—	—
	Total	166	14	3	—	(1)

CCB = Circular ciliary band vessel
RI = Radial iris vessel

CCB + RI = Circular ciliary band and radial iris vessels
RCB-Tr = Radial ciliary body band or trabecular vessels
() = In combination with other angle vessels.

Several patients were examined with the gonioscope on two or more occasions without any noticeable change in the position or appearance of the vessels.

Three distinct types of vessels were noted:

- (a) Circular ciliary band vessels (or circular iris root vessels);
- (b) Radial iris vessels;
- (c) Radial ciliary band or trabecular vessels.

The "bunch" vessels mentioned by Chatterjee (1960) were not seen. The first two types were the most common and were noted either alone or in combination. Radial ciliary band or trabecular vessels were uncommon (there were eleven instances, nine in blue eyes, and two in brown), and except for one instance were noted in the presence of one or the other type of angle vessel.

Description of Angle Vessels (Fig. 1, opposite)

(1) Circular Ciliary Band Vessels (CCB)

Gonioscopy.—This was the type of vessel most frequently seen. Its usual location was in the region of the ciliary band just within, or upon, the surface of the ciliary body. Occasionally in medium-angle eyes a segment of vessel appeared to lie

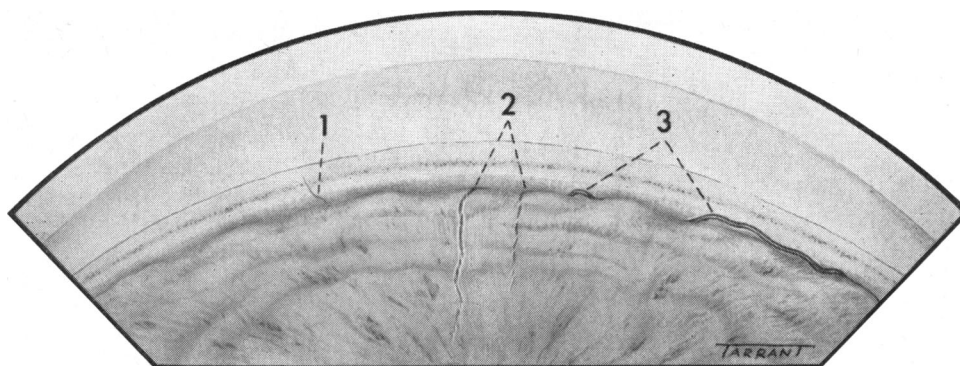


FIG. 1.—Composite drawing of angle vessels seen in normal eyes.

(1) Radial ciliary body or trabecular vessel. (2) Radial iris vessel. (3) Circular ciliary band vessel.

slightly anterior to the ciliary body, just behind the last roll of the iris. Though generally appearing in isolated segments of broad calibre, the vessel was several times (in wide-angle eyes) seen almost in its entirety, taking a sinuous route around the entire angle. Usually red, unsheathed, and of uniform width, the vessel was sometimes partially or completely sheathed in white, in which case the blood column appeared thinned and less red than in the unsheathed state. Without doubt, this visible circular vessel is the major arterial circle of the iris, and in several instances radial iris vessels could be seen emanating from it.

Anatomy.—The major arterial circle of the iris is formed by the anastomoses of terminal branches of the medial and lateral long posterior ciliary arteries, and the anterior ciliary arteries. The circle may divide into several channels which then re-unite to form the main circle (Duke-Elder, 1961a). While the arterial circle is described as running round the anterior part of the ciliary body just behind the root of the iris (Duke-Elder, 1961b), its position may be quite variable even in the same eye. It may lie within the root of the iris (Fig. 2), within the ciliary body (Fig. 3),

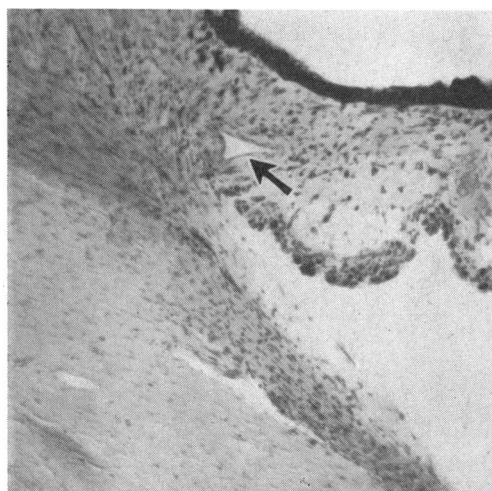


FIG. 2.—Major arterial circle of iris lying within iris root. (From patient with vitreous haemorrhage). 128 ×.

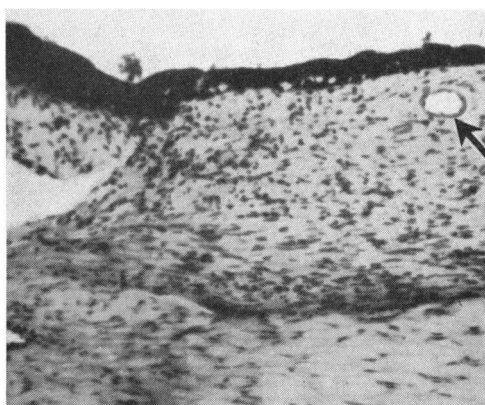


FIG. 3.—Major arterial circle of the iris noted in the ciliary body far from the angle. (Patient died of CO₂ poisoning). 128 ×.



FIG. 4.—Major arterial circle of the iris noted within the angle. (Patient with malignant melanoma of choroid). Reticulum stain. 128 ×.

vessels are seen in one eye. They appear to be arterioles emanating from the major arterial circle of the iris, though some may indeed be venous channels draining the iris.

Anatomy.—On section these vessels can be seen on occasion to arise from the major arterial circle of the iris (Fig. 5) and to lie rather superficially in the iris root. As a rule, their origin is not visible (Fig. 6).

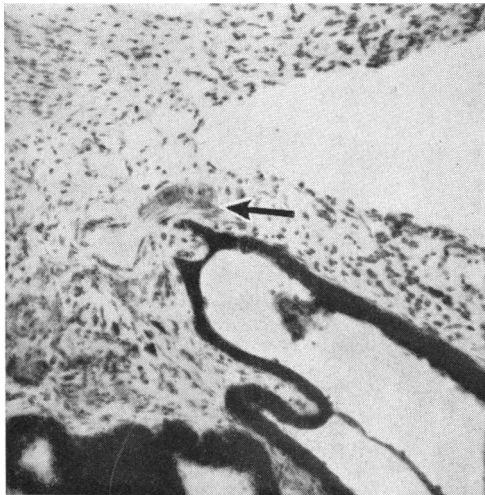


FIG. 5.—Radial iris root vessel emanating from the major arterial circle of the iris. (Patient with *Toxocara endophthalmitis*). 128 ×.

and, rarely, within the angle itself (Fig. 4). Occasionally a section of the major circle will appear prominent on one side of the specimen and be absent on the other side.

(2) Radial Iris Vessels (RI)

Gonioscopy.—These vessels appear at the iris root, generally as short segments disappearing into the substance of the iris. Often they seem to hook over the last roll of the iris. Occasionally in light-blue eyes the vessels can be traced axially to the mid-zone of the iris, where they then disappear into the deeper iris. Invariably they appear as rather straight narrow blood columns ensheathed in white. When visible, as few as one or more than ten such

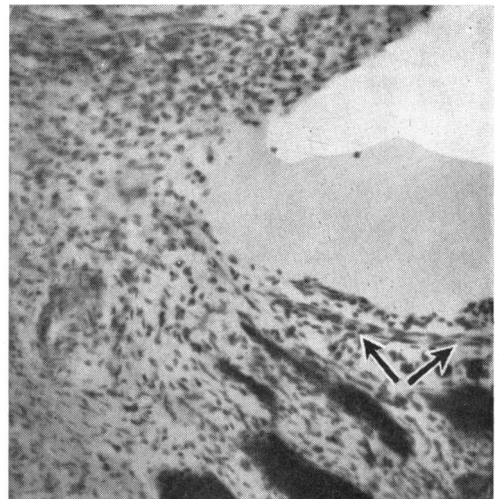


FIG. 6.—Radial iris root vessel superficially placed and without obvious connexion to the major arterial circle of the iris. Same patient as Fig. 5). 128 ×.

(3) Radial Ciliary Body or Trabecular Vessels (RCB-Tr)

Gonioscopy.—These are the least common of the vessels seen in the angle of normal eyes. They appear to lie deeply within the ciliary body band or trabecular region, and present simply as a thin linear red streak running at right angles to the plane of the iris. In no case could their origin from other vessels be seen, nor did they connect with the canal of Schlemm. When such a vessel was seen in eyes containing blood in Schlemm's canal there was no apparent connexion between the vessel and the canal. It is probable that these vessels are either branches of the arterial supply to the canal of Schlemm, or portions of the deeper scleral plexus.

Anatomy.—No definite anatomic correlation for these vessels could be provided in this study. They are probably branches of the arterial circle in the area of Schlemm's canal, which has been demonstrated by neoprene cast techniques (Ashton and Smith, 1953).

Discussion

This work was prompted by the findings on gonioscopy of several types of vessels within the angles of many normal eyes. At first, the possibility of developmental abnormality or neovascularization was considered, but the relatively frequent appearance of such vessels was unlikely to be due to either cause, particularly in otherwise normal eyes. A review of major text-books on gonioscopy proved quite unrewarding.

François (1948) briefly mentioned that one might see in normal eyes a superficial circular vessel of varying length and sinuous path. Gorin and Posner (1961) state that:

“Blood vessels are seen occasionally at the junction of the root of the iris and the ciliary body. In some eyes a long vessel, a branch of the major arterial circle, runs for variable distances along the ciliary margin of the iris. In other cases several short vessels are seen to take a more or less meridional direction. These vessels are frequently seen in light-coloured eyes, almost never in brown eyes”.

Troncoso (1948), Busacca (1945), and Shaffer (1962) make no specific mention of vessels as part of the normal appearance of the angle on gonioscopy. Duke-Elder (1962), discussing gonioscopy in his *System of Ophthalmology*, gives a beautiful description of the gonioscopic appearance of the major circle of the iris:

“showing to a variable degree the vessels taking part in the major arterial circle of the iris; these vessels may be quite prominent, loops and coils projecting forwards almost in the manner of a sea-serpent near the surface of the water.”

He does not mention other angle vessels in his discussion; in 1951, however, he wrote that “in blue-eyed persons the band of the ciliary body is of faintly orange or yellow colour, and in such eyes fine vessels may be seen coursing underneath the surface” (Duke-Elder and Goldsmith, 1951).

Of the numerous articles written on various aspects of gonioscopy, only the recent one by Chatterjee (1960) provides data on vessels in the normal angle seen on gonioscopy. In a study of 100 normal eyes he found 65 per cent. to have circular ciliary band vessels, 12 per cent. to have radial iris root vessels (in blue-eyed individuals

only), and "bunch" vessels in two patients. Braley and Allen (1955) briefly mention that fine radially or irregularly arranged vessels in or near the apex of the chamber angle may be seen in normal young eyes. Redslob (1939) shows a diagram "*d'après* Trantas" of a vessel that appears to be a radial ciliary band vessel in a normal eye.

Though infrequently or scantily mentioned, vessels are not uncommon in normal angles. Their appearance depends on the width of the angle, the pigmentation of the iris and ciliary body, and the anatomical variations of the vessels involved.

The colour of the eye appears to be the major factor in the visibility of angle vessels. Vessels were noted approximately seven times more frequently in blue than in brown eyes. In 41 normal deeply-pigmented eyes of Negro patients, no vessels were noted in the angle, although more than half of these eyes had wide angles.

Vessels were noted most frequently in eyes with gonioscopically wide angles. Whether this is due simply to the more extensive view of the depths of the angle, or whether some anatomic factor is also involved, could not be determined in this study.

Anatomical variations must also play a role if vessels are to be seen gonioscopically. Particularly the location of the major arterial circle of the iris may vary markedly from eye to eye or within the same eye. Deep placement in the ciliary body would preclude a sight of this vessel even in the light-blue eye with wide open angle. Likewise, a thick iris root may hide radial iris vessels.

It is difficult to assess the "neovascularization", aberrant vessels, and vascular anomalies of the angle mentioned in the literature in regard to various ocular disorders. For example, the large circular vessel occasionally seen in the angle in buphthalmos (François, 1948, p. 73, fig. 53) would appear to be the major arterial circle. Should it be considered anomalous? Likewise, radial vessels in the trabecular zone are mentioned as occurring frequently (in five out of fifteen cases according to Franceschetti (1955); and in three out of fifteen cases according to Vannini (quoted by Franceschetti) in heterochromic cyclitis), but they may also occur in non-diseased eyes. Unless the iris colour and angle width are mentioned, it will be hard to assess pathological angle vessels. One exception would be in rubeosis iridis, where the vessels occur in an irregular fashion, often both at the root and pupillary portion of the iris, and accompany other evidence of ocular disease, almost always involving the retinal vessels.

Summary

Gonioscopic examination of the angle revealed the presence of vessels in seventy of 269 normal eyes. They were much more frequent in blue-eyed patients, and were not seen at all in the negroid eyes studied. Vessels appeared more commonly in wide-angle eyes than in medium or narrow-angle eyes.

The vessels were of three types:

- (1) A circular ciliary band vessel, anatomically the major arterial circle of the iris;
- (2) Radial iris root vessels, generally arterioles from the major circle lying superficially in the iris root;
- (3) Radial ciliary band or trabecular vessels, thought to be vessels either of the deep scleral plexus or of the arterial circle of Schlemm's canal.

So-called anomalous or new vessels found in the angle must be considered in the light of the vessels normally seen in the angle.

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