ANOMALIES OF RETINAL VASCULATURE

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The normal retinal vasculature emerges from the nasal side of the optic cup. There are inferior and superior branches of both veins and arteries that soon divide again to create a major branch of each to each quadrant of the retina. The artery usually emerges nasal to the vein. In the normal retina there is a horizontal raphe across which the retinal vasculature either superiorly or inferiorly does not cross. As with any biological organism, variations from the normal vascular system can exist. An understanding of normal variations of the retinal vasculature, their frequency and types, can be useful to the ophthalmoscopist in differentiating disease conditions from benign variations.

Duke Edler in his Systems of Ophthalmology mentions the following major variations from the normal retinal vasculature[1].

1. More than two branches of the vein or artery emerging on the face of the cup. Noted as rare by Duke Elder.

2. Confluence of three branches of a vein.

3. Trifurcation of a retinal artery. Normally two side branches leave the artery at right angles to the larger center branch in this anomaly.

4. Bifurcation of a vein at the disc.

5. A superior branch of an artery supplying the inferior retina of vice versa.

6. Tortuosity of retinal vessels, either generalized or localized, may be either unilateral or bilateral.

7. Enlargement of the veins. This is frequently bilateral and symmetrical.

8. Dialation of retinal capillaries at the disc.

9. Situs inversus, which he attributed to tilting of the nerve head.

10. Abnormal macular vessels. These are rare. Most are from the inferior temporal artery or vein and may either embrace or run over the fovea. They may also cross the horizontal raphe.

11. Vascular loops in the vitreous. These occur at the optic disc and are normally arterial and unilateral.

12. Arterial-venous communications. Duke Elder states that these are very rare with most vessels that are thought to be cilioretinal actually being very early arising branches of the central retinal artery.

Khalial J. Awan, M.D. made two major studies of nonpathological variations of the normal retinal vasculature.[2,3] One of 1,400 eyes in which he studied venous abnormalities and the other of 2,100 consecutive eyes in which he studied the arterial system. Awan looked at the following variations from the norm:

1. Triconfluence of retinal veins. He found a prevalence of .8%.

2. The superior retinal quadrant being drained by an inferior quadrant vein or vice versa. A .7% prevalence.

3. Bifurcation of a retinal vein at the disc. A prevalence of .7% was found.

4. Anomolous venous tortuosity. In which he found a prevalence of 1.9%.

5. Trifurcation of retinal arterioles. A prevalence of .66%.

6. The inferior temporal artery being supplied by a branch of the superior temporal artery or vice versa. A .9% prevalence.

7. A nasal quadrant artery being crossed by a temporal quadrant artery. A .42% prevalence.

8. A branch of a retinal artery was found by Awan running back of the disc. A prevalence of .19%.

9. Arterial-Venous pattern reversed with the artery emerging from the disc temporal to the vein. He found a .14% prevalence.

10. Anomolous tortuosity of a retinal artery. A .48% prevalence.

11. Macula being embraced by a macular artery. A prevalence of .9%.

12. Cilioretinal arteries. A 17.5% prevalence.

Another major study by Justin and Helmamn used fluorescein angiography with magnified stereophotography to determine the presence of cilioretinal arteries in 1000 patients.[4] They found that 32.1% of the eyes examined had cilioretinal arteries. In 18.7% these arteries contributed to some portion of macular circulation.

A number of discrepancies occur in the literature on the topic of retinal vasculature anomalies. Awan found a .8% prevalence of venous triconfluence and a prevalence of .66% for trifurcation of retinal arterioles.[2,3] Collier claimed that 10% of subjects had a trifurcation with those on the arterial side of circulations being twice as common as those on the venous side.[5] Chisholm noted in his study that venous triconfluence was much rarer than arterial trifurcation.[5] Gaus found that 15.3% of normal patients have some congenital tortuosity of the retinal arteries and 8% of the retinal veins showed the same.[1] Awan found a prevalence of venous tortuosity of 1.9% and of .48% for the arterial system.[2,3] Walsh and Hoyt agree with Awan's study.[3]

In this study I examined slides taken at the Ferris State College of Optometry. These slides were of a variety of pathological and non-pathological conditions. The slides used in the study showed the optic

disc and an area of at least two - three disc diameters in all directions from the disc. In addition, slides were eliminated if they showed pathological conditions that may have altered the normal patterns of the retina's vasculature. A total of 1,183 slides were examined of which 308 met the conditions of the study.

The purpose of this study was to determine the prevalence of non-pathological retinal vascular variations. These were compared with data reported in the literature to attempt to resolve previously mentioned discrepancies between authors.

The types of variations from the norm mentioned by Duke Elder and Awan were used as the basis for the data collected. A 66mm by 66mm illuminated slide viewer was used to look at the slides. Those with suspected vascular variations were then projected on a screen to confirm or deny the existance of the variations using the projectors greater magnification.

Justin and Helmamn in their study of cilioretinal vessels used fluorescein angiography with magnified stereophotography.[4] They concluded that cilioretinal vessels were distinguished from vessels that arose early from the central retinal artery by making a hook after emerging from the disc and before coursing out over the retina. When using fluorescein angiography the cilioretinal vessels will fill before those of the retinal arterial system. Thus they can be distinguished from arteries arising from the central retinal artery. The presence of this hook was used in this study when determining if a vessel was cilioretinal or not.

A prevalence of 8.1% was found for cilioretinal vessels of which 32%

contributed to the macular circulation. This compares with a prevalence of 17.5% found by Awan.[2,3] Justin and Helmamn found that 32.1% of the eyes they examined had cilioretinal vessesls of which 29% contributed to the macular circulation.[4] Duane's Clinical Ophthalmology states that 20% of normal eyes have cilioretinal vessels. Duke Elder stated that cilioretinal vessels were rare.[1] The data from my study agrees more with Duke Elder than with the other studies mentioned. Insistance upon the vessel making a hook when the vessel emerges from the disc and the high magnification provided when the slides were projected on a screen kept the number of cilioretinal vessels counted low. However, I did not have the benefit of fluorescein angiography so comparison of my data with that of Justin and Helmamn may be inappropriate. The importance of cilioretinal vessels lies in the high percentage of them that contribute to macular circulation. These may be the cause of some cases of macular sparing when vision is lost in vascular occlusive disease.

Of all of the slides examined, 3.6% showed tortuosity of the arterial vascular system and .64% showed the same of the venous retinal circulation. Gaus said that 16% of the population evidenced retinal vascular tortuosity with that of the arterial system being twice as common as that of the venous system.[1] Walsh, Hoyt and Awan all found that tortuosity of the venous system was twice that of the arterial system.[3] Awan found a prevalence of .48% for arterial tortuosity and 1.9% for venous tortuosity.[2,3] My data gives a ratio of arterial to venous tortuosity similar to that of Gaus but a prevalence similar to Awan's.

In my study 4.8% of the slides studied showed a trifurcation of the arterial vasculature. In two of the slides there were two trifurcations. This compares with a prevalence of .66% found in Awan's study. Collier

found a prevalence for arterial trifurcation of 10%.[5] Awan stated that in an arterial trifurcation generally two branches would run off at 90° angles to the main arterial branch.[3] Duke Elder said the same thing. I found this same pattern in my study also.

Venous triconfluence was slightly more than half as common as arterial confluence in my study. I found a prevalence of 2.9%. This contrasts with Awan's two studies. He found a prevalence of venous triconfluence of .8%.[2,3] A figure slightly larger than that which he found for arterial trifurcations. Collier, however, found arterial trifurcations to be twice as common as venous triconfluence.[5] Chisholm stated that venous triconfluence was much rarer than arterial trifurcation.[4] My study showed results similar to those of Collier and Chisholm. Venous triconfluences followed the same pattern as arterial trifurcations. Most consisted of two small branch veins coming in at right angles to the main venous branch.

In his discussion of abnormal retinal vessels Duke Elder refers to aberrent macular vessels. He describes them as branch arteries or veins that may run directly over the macula or may just before the macula bifurcate into two branches that embrace the macula. Duke Elder describes such vessels as rare.[1] I found no such cases like those described by Duke Elder. I did find a prevalence of 1.3% for arterial branches that ran to and appeared to stop directly at the macula. Awan found a prevalence of .9% for macular arteries that come off the central retinal artery and ran directly to the macula.[3] He stated that many of these branches bifurcated just before the macula with the two resulting branches embracing the macula.

Duke Elder mentions vascular loops in the vitreous.[1] He states that they are patent, associated with the optic disc and usually arterial. Duke Edler states that these loops represent irregular budding from the bulb of the hyaloid artery at Bergmeister's papilla. He postulates that they originate at the 100mm embryol stage. Gadel proposed two theories for the cause of retinal vascular loops.[6] He believed that they may be due to an excess accumulation of metabolites in the developing embryol that creates a relative anoxia. This anoxia causes a need for an increased blood supply and the vascular loops develop to supply it. His other theory is that the loops are caused by premature closure of the hyaloid artery. The premature closure casues an increased intralumen pressure in any laterally growing vessels that may exist. This increased pressure results in the development of these laterally growing vessels into vascular loops. Although vascular loops were mentioned in a number of studies only Awan mentioned their prevalence. He found one example (a prevalence of .07%). In my study I also found one such vascular loop. This would give a prevalence of .64%.

Duke Elder describes an anomaly in which an artery and vein are intertwined around each other as they emerge from the disc. In my study I found three such anomalies for an incidence of .97%.

Duke Elder talks about one branch of an arteriole crossing another or one branch of a vein crossing another. He states this happens very rarely.[1] Awan disagreed. He found in his study a prevalence of vein - vein crossings of .7% and of arterial - arterial crossings of .42%. In my study I found only one example of an arterial crossing another for a prevalence of .32%. I found no examples of venule - venule crossings. My study thus agrees with Duke Elder that such crossings are rare. Awan

has proposed a theory for the development of arterial - arterial crossings, venous - venous crossings and other abnormal directioning of the retinal vasculature in the area near the optic disc.[3] He believes that these abnormal patterns result from an irregular gradual atrophy of Bergmeister's papilla so that it lays down on the retina in an unusual fashion. He describes a superior retinal quadrant being drained by a venule branch of an inferior quadrant vein or vice versa (he found a prevalence of 2.6%) and the inferior temporal retina supplied via the superior temporal artery or vice versa (a prevalence of .92% was found by Awan).[2,3] In my study I found no example of this type of retinal vascular anomaly.

In my study I noted that the inferior temporal vein was usually larger than the inferior nasal branch. In 1.5% of the slides examined the dominance of the inferior temporal vein over the nasal vein was pronounced to such a degree that branches of the inferior temporal vein were draining part of the inferior nasal retina. This tendency was more pronounced in one case where the inferior vein bifurcated right at the edge of the disc sending a much smaller nasal branch off at a right angle to the main inferior vein which coursed inferiorly down the midline of the retina sending off branches nasally and temporally. This trend was finalized in one case in which there was one main inferior vein running straight down from the disc. As it ran inferiorly it gave off smaller branches nasally and temporally at right angles to its own direction.

Unusual and or misdirected vessels of the retinal vasculature are important in pathology diagnosis. The presence of cilioretinal vessels can contribute significantly to the retinal blood supply. Especially important is their prepencity to supply the macular area.

The presence of such cilioretinal vessels might disguise diseases involving insufficiencies of the retinal arterial vasculature by altering expected visual field defects or visual acuity loss. Unusual retinal vessels other than cilioretinal vessels might perhaps do the same thing. An unusual source of macular blood supply by keeping visual acuity normal, could camouflage retinal disease long after such a disease would normally have detected. Tortuosity of retinal vessels has been established to occur fairly commonly in normal eyes. It is useful to keep this in mind when doing ophthalmoscopy.

The major retinal vascular anomalies noted in this study were cilioretinal vessels, trifurcation or triconfluence of retinal vessels, and vascular tortuosity. I found a prevalence of cilioretinal vessels of 8.1%. This figure was generally lower than the figures generally reported in the literature. It tends to agree with Duke Elder's opinion. Trifurcations of retinal arterioles were twice as common as triconfluence of the retinal veins (4.8% to 2.9%). This contradicted Awan's study and agreed with Collier and Chisholm's. Tortuosity of the arterial system was more common than that of the venous system (3.6% to .64%). This ratio was in agreement with Gaus and disagreement with Hoyt, Walsh, and Awan. The prevalence of the anomally was found to be of the same magnitude as that found by Awan.

R E F E R E N C E S

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