A DISCUSSION ON THE RELATIONSHIP BETWEEN IOP, OPHTHALMODYNAMOMETRY, AND SYSTEMIC BP IN THE NORMAL AND OCULAR HYPERTENSIVE.

CRAIG FIDLER
FERRIS STATE COLLEGE
COLLEGE OF OPTOMETRY

1979

A DISCUSSION ON THE RELATIONSHIP BETWEEN IOP, OPHTHALMODYNANAMOMETRY & SYSTEMIC BP IN THE NORMAL AND OCULAR HYPERTENSIVE

In the course of clinical optometric practice, optometrists often encounter patients with elevated IOP and must conclude if this is merely a normal finding or pathological. The most accepted philosophy at present in making a diagnosis of glaucoma states that there must be these three clinical findings; 1) excessive physiological cupping of the optic nervehead, 2) a visual-field defect must be present, and of course, 3) elevated IOP. Most types of glaucoma have these characteristics. A more precise definition can be made by simply stating that there is a decrease in vision due to the pressure in the eye being greater than the profusion pressure of the vasculature which nourishes the optic nerve head. This definition would include the low tension types of glaucoma. We are then assuming that nerve fibre damage results from ischemia due to pressure on the vessels.

It would seem logical that if we could determine the difference in pressure between 1) the pressure within the eye and 2) the pressure within the vasculature of the optic nervehead, then we would know how close the nervehead would be from being damaged by ischemia if there was an increase in IOP. The greater ~~that~~ this pressure difference is, would represent a "safety zone." Consider, for example, two patients with suspicious IOP's of 25mmHg. In the first patient it takes an additional 2mmHg to exceed the profusion pressure

of the optic nervehead vasculature. In the second patient we find that it takes 15mmHg increase to cause blood stasis. From this we might comclude that the first patient is in danger and the second patient is not. To take this one step further, what if we measured this "safety Zone" on all patients regardless of their IOP? Would this be a more diagnostic procedure than our present methods of diagnosing glaucoma? This might be a clinical tool which would answer the question..."Is this patients elevated IOP normal or glaucomatous?" If we could determine the relationship between IOP and the nervehead vasculature and define what is a "safety zone" then we could eliminate the tedious repetition of tonometry and visual fields neccessary to be sure of a correct diagnosis. We wouldn't have to "wait" for a field defect to manifest before treatment. Our diagnosis would be on a more sound basis.

How are we going to do this? First, what we must determine is how to measure the pressure of the vasculature at the nervehead. Well, this has already been done with an ophthalmodynamometer(ODM). The next step would be to define and describe the relationship between IOP and ODN (as you'll see this cannot be done without considering the effect of systemic blood pressure). This was done by Fidler(1979) and he found that there was absolutely no relationship? between IOP and ODN measurements.(Appendix A) This is not surprising, this could have been predicted theoretically. We already know that the profusion pressure of the ophthalmic/central retinal

arteries varies with systemic blood pressure (brachial). We also know that IOP varies rather significantly with systemic BP, however a sound relationship has not been established. In order to determine how close the disc is to ischemic damage, to determine this difference in vascular pressure & IOP, and to develop parameters which define a "safety zone," we must evaluate the relationship of 1) ODM, 2) systemic BP and 3) tonometry/IOP. The relationship between ODN and systemic BP has already been documented. without any question. Clinically, ODM is used most effectively in the diagnosis of carotid artery stenosis/disease. Only relative values, rather than absolute, have been used to compare the two eyes (and make inferences about the carotid arteries). It remains to be seen just how IOP, ODM and systemic BP relate to each other. In the next few pages I would like to discuss what we do know about these relationships and some of the problems that are encountered.

Before getting into the relationship between BP and IOP, I would like to say a few words about ODM. The most commonly used instrument is the Balliet Dial type which is a plunger attached to a spring and register dial system. There are many factors that affect the readings. I feel that the technique of the clinician is the most common factor for variation in results (this includes the ability of the examiner to keep the patient from becoming apprehensive

and squirming around. The quality of the instrument has also been criticized. There is another type of ODM of the market (very difficult to obtain and very expensive) which is mounted on a biomicroscope similar to an applanation tonometer. The examiner views the fundus through the center of the lens while varying the force applied to the cornea. Even with this sophisticated set-up the reliability of the test is questionable.

Cullen et al (1974) compared the applanation IOP's with brachial artery pressure and a significant correlation between BP and IOP(r=0.778). As the systolic BP's increased, so did the IOP. Zuckerman developed a ratio between systolic BP and IOP. (BP/IOP), and stated that a ratio of greater than five (5) was indicative of a good prognosis with respect to field losses in glaucomatous patients. In other words, if the IOP was elevated, you probably would not encounter a field defect if the BP was high enough to "drive" blood into the eye. We see that this has validity in that patients over-medicated for systemic hypertension can developed a type of low tension glaucoma. This is not to say that high BP, or low BP will cause glaucoma (outflow facility must be considered). Cullen also states that "We have confirmed the results of other investigators that IOP is proportional to BP...considering ocular hemodynamics...there is some dependance upon BP for the maintainance of PP (papillary Profusion pressure) the relationship need not be linear." Cullen plots IOP, and PP

versus BP which basically says that the systemic BP must be high enough to drive the blood through the vasculature affected by the IOP. He goes on to say that " the mere fact that IOP is above normal does not neccessarily confirm a diagnosis of glaucoma any more than a figure within the normal range or below eliminated the possibility of the disease." This statement demonstrates further the need to determine an effective way to measure the difference in IOP and PP, and determine the relationship between them ("safety Zone").

It seems like Cullen is contradicting himself when he says that with increase BP you get an increase in IOP (r=0.778), and then talks about glaucoma with low systemic BP. I think this can be explained by the basic mechanism of aqueous production. High systemic BP's would increase the filtration component of elevation of IOP (secretion and outflow changed insignificantly). When a low systemic BP exists, there is little filtration production of aqueous, however, the IOP is maintained at a given level by secretory production of aqueous. What portion of IOP is attributable to filtration? Secretion? Do they vary in different patients? Is this why some patients respond to secretion inhibition drugs (Diamox) better than others...perhaps a greater portion of their aqueous is produced by secretion, and not filtration??

There are a lot of answered questions. I feel that the key to an effective, reliable clinical tool can be found in the developement of measuring the difference in the profusion

pressure of the vasculature of the optic nerve-head as it relates to IOP. Of course we must first understand the relationship of BP,IOP, ODM, filtration vs. secretion & outflow facility. At this point it appears that the biggest problem is in the inaccuracy of the present ophthalmodynamometers available.

I thought you were going to compare IOP, OOM, + BP.?

BIBLIOGRAPHY

1) Leighton and Phillips, SYSTEMIC BP IN OPEN ANGLE GLAUCOMA, LOW TENSION GLAUCOMA, ANB THE NORMAL EYE, Dept. of Ophthalmology,U of Manchester, Royal Eye Hospital.

2) Cullen, Sharp, Moore, McCoy, SYSTEMIC BP AS A DIAGNOSTIC TOOL IN GLAUCOMA, Am. Journ. Opt. & Phys. Optics, vol.51 no.6, June 1974

3) Walsh and Hoyt, CLINICAL NEURO-OPHTHALMOLOGY, Williams and Wilkins 1968

4) Newell and Earnst, OPHTHALMOLOGY* PRINCIPALS AND CONCEPTS 3ed. Mosby 1974

5) Duane, CLINICAL OPHTHALMOLOGY, Hagerstown, Maryland, 1978

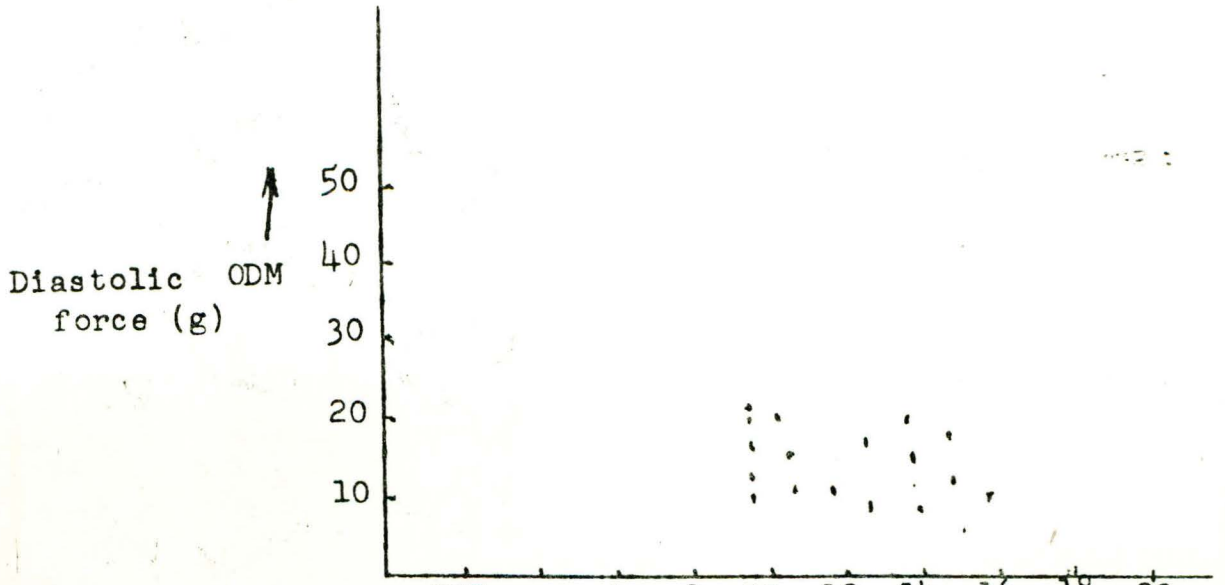
6) Carter, R.L., lecture notes, Ferris State College of Optometry, 1976-7

7) Adler, PHYSIOLOGY OF THE EYE, Moses Ed, Mosby 1975

8) Fraunfelder, DRUG INDUCED OCULAR SIDE EFFECTS & DRUG INTERACTIONS, Lea & Febiger, 1976

9) SYMPOSIUM ON NEURO-OPHTHALMOLOGY, Mosby 1976

APPENDIX A



Your work is not very well explained.

CONCLUSION: NO CORRELATION BETWEEN IOP AND ODM.

There is a correlation but it is probably close to 0. You should have computed the correlation.