No. 21

THE CAMBRIDGE GLAUCOMA LETTER

published by THE CAMBRIDGE GLAUCOMA FOUNDATION, INC.

Low Tension Glaucoma

There comes a time in the education of every ophthalmologist-to-be, while yet a medical student, or early in his residency program, when, pleased with his newly acquired understanding of open angle glaucoma as a disease caused by elevated intraocular pressure and characterized by excavation of the optic nerve head and by progressive loss of the visual field, he is confronted with the description of yet another disease, which is called glaucoma and yet is not glaucoma, a shadow of the original, which it belies and repudiates. Having just accepted on faith that glaucoma results from elevated tension, he is now asked to believe that glaucoma can also develop in the normotensive eye. He dares not challenge his preceptors. Trained by long years of sitting through lectures to accept the words of the professor as truth, he has learned that it is safer to insult ones intelligence than ones teacher. He marvels at the wisdom that can reconcile such apparently contradictory definitions, and being a dutiful pupil, promptly busies himself with integrating yet another paradox into the thesaurus of his own memory. And it is not long until he too firmly believes in the existence of two entities whose definitions are mutually exclusive, gives "correct" answers to the examination questions, and is launched on an illustrious career of teaching, research and medical practice, based on his "understanding" of this contradiction and many others like it.

It is useful by way of introduction to consider the term low tension glaucoma as just that, a term, a word whose primary function, as is the case with all language, is to serve as a vehicle of communication, an answer that we list on our examination forms in order to receive passing grades, a word that we utter in answer to our patient's question "Doctor, what have I got?" an ICD-9-CM code that we enter on the HCFA-1500 request for payment so that our Medicare checks may be doled out to us. In what respect, or to what extent a disease such as "low tension glaucoma" exists in reality, in nature, in some realm, whatever one chooses call it, independent of our cognitive conjectures, is a meaningless question, since that realm of ontologic integrity beyond our knowledge is by definition a paradise from which we are excluded. It serves, like that other paradise of religious tradition, as a compelling reminder of human inadequacies. Our task, as always, is the tedious collation of the words by which we communicate with the reflections of individual experience, however fragmentary they might be.

The names that first make us aware of the existence of diseases, tend also to serve as barriers to our understanding of them. Not least in this regard is the name "glaucoma" itself, The Greek adjective "glaukos" appears to have meant bluish-green when applied to the ocean, gleaming or flashing when describing the eyes, so that it is not clear whether "glaucoma" originally referred to the bluish haze of a dense corneal scar or merely to the disquieting gleam, unmodulated by responses to visual stimuli, of the non-seeing eye. Glaucoma almost certainly did not mean, as a seventeenth century ophthalmologist once surmised, that the patient was afflicted with bluish-green vision. The term "low tension glaucoma" compounds the etymological disarray, since the pressures at which it occurs are low only in comparison with those of the glaucomatous eye, but are otherwise normal.

The term low tension glaucoma, as is well understood, is reserved for a disease where in the presence of normal pressures, there occur disc excavation and field loss otherwise indistinguishable from that of open angle glaucoma. Perplexity arises from the circumstance that in glaucoma, elevated intra-ocular pressure is assumed to be the indispensable primary cause of disc excavation and field loss. In "low tension glaucoma" these processes take place at normal pressures. The postulate of "low tension glaucoma" requires us to assume that a cause other than ocular hypertension initiates the process of disc destruction, but as of now, no such cause has been produced. Until that cause is identified, not only will the diagnosis and treatment of low tension glaucoma remain uncertain, but the diagnosis and treatment of open angle glaucoma will also to some extent be put in doubt, for the unknown factor responsible for disc excavation in low tension glaucoma must be as-

sumed to have at least a potential role in the genesis and progression of open angle glaucoma as well.

We must take care not to confuse low tension glaucoma with a late stage of open angle glaucoma that resembles it. Here too, when cupping is far advanced, glaucomatous field loss may progress even though medication or filtering surgery have reduced the pressure into the statistically normal range. The eye may then behave as if it had low tension glaucoma in that it continues to lose field although the pressure is normal. This situation differs from low tension glaucoma however, in that the initial insult to the optic nerve was caused by pathologically elevated tension, while in true low tension glaucoma the destruction of the nerve is assumed to have occurred entirely at statistically normal intraocular pressures.

Fundamental to the definition of low tension glaucoma is the determination of the intraocular pressure, that most elementary of diagnostic glaucoma procedures whose difficulties have not been entirely resolved. When we state that the intraocular pressure in a given eye is 10 or 15 or 25, we quote the results of but a single measurement. Even when the tonometer is precisely calibrated and the technique of measurement is impeccable, the accuracy of measurement is limited by the variable tonus of the extraocular muscles, for when these muscles become abnormally tense in reflex response to the application of the instrument, the pressure in the eye will rise transiently, and when the muscles relax it will fall and overshoot its undisturbed levels. Thus in a patient who is unable to relax his extraocular muscles during tonometry, it may be impossible to obtain an accurate reading.

Of comparable importance are the spontaneous fluctuations of the intraocular pressure that occur at several frequencies. Most obvious is the intraocular pulse, which can be readily identified because it is synchronous with the beat of the heart. Fluctuations, on the other hand, which have periods of minutes or hours or days cannot be detected at any given tonometry session, but must be inferred from sequential readings. In general we tend to attribute disproportionate importance to the most recent tonometry value. We reason as if we could not trust the antecendent values, as if somehow our present concern for the patient's problem reduced the validity of previous observations. From a mathematical perspective, any single tonometry value should concern us only as a sample from a statistical population. What we really need to know are the statistical parameters of the pressure as a function of time, the mean, the standard deviation, the correlation coefficient and the confidence intervals. Optimally one would like to see a Fourier analysis to identify the periodicities that combine to account for the variations of pressure in the glaucomatous eye. Fourier analysis, however, requires a set of measurements far more closely spaced than is feasible in clinical practice.

If these methodological deficiencies in our work are of no practical consequence, this is the case because the majority of unselected patients does not have glaucoma, and because many cases of early open angle glaucoma, if we discovered them at the inception of the disease, would require no treatment. Moreover, undertreatment in the early stages of the disease becomes apparent only after months or more likely years have passed. In general, therapy is prescribed only when the disease is beyond its initial stages, and at that point the diseconomies of possible overtreatment are usually outweighed by the margin of safety that a potentially lower pressure is likely to entail. One would think that our greatest need for exact information about intraocular pressure would arise when a determination concerning filtering surgery is to be made, but at that juncture, paradoxically, the precise behavior of the pressure seems of less importance, because our decision to operate rests on an overall assessment of the course of the disease.

For the definition of the glaucoma, for understanding its pathophysiology, on the other hand, the arbitrary acceptance of random pressure measurements is unacceptable and a more precise description of the intraocular pressure is indispensable. Notwithstanding the relative ease of obtaining a single pressure measurement, it is remarkably awkward to obtain the numerous tonometries over a protracted period of time which would be requisite for a sufficient description of the disease. This is particularly the case where, unlike open angle glaucoma, whose initial phase is characterized by mild elevations of pressure, in low tension glaucoma the pressure is by definition normal, and the initial sign of illness is the excavation of the optic nerve head whose early phases are so extraordinarily difficult to distinguish. In order to obtain data on the genesis of low tension glaucoma one would have to make sequential measurements of pressure on a large and presumably normal population, a very small proportion of of whom would ultimately develop this relatively rare disease.

As we confront the challenge of searching for the etiology of low tension glaucoma, be it by laboratory or by clinical investigation, we do well to remind ourselves that the phenomena which puzzle us may also be explained in terms of what we already know about glaucoma.

Let us suppose for a moment that there were a disorder characterized by in-

termittent recurrent pressure elevations. The less frequently routine tonometry is performed, the more likely that such tension elevations would go undetected. It seems plausible to me, given the sporadic tonometry to which most of the presumably healthy population is presently subjected, that such a disorder would frequently be overlooked. Suppose further that for one reason or another, these pressure elevations were self-limited and subsided spontaneously after a period of time, much as does the glaucoma that sometimes accompanies iritis, then it is altogether conceivable that the disc might be surreptitiously excavated by periods of unrecorded elevated tension. Later the compromised disc would prove incapable of tolerating even a normal pressure, and excavation and field loss would progress even after the tension had come down to normal. In time the patient arrives at the the ophthalmologist's with a classical case of low tension glaucoma.

A second plausible explanation of low tension glaucoma reflects the circumstance that we measure the intraocular pressure with reference to atmospheric pressure, while the physiologic effect is exerted, as a brief reflection on simple anatomic relationships will confirm, against the pressure that happens to prevail behind the lamina cribrosa, which is not the pressure of the atmosphere but of the cerebrospinal fluid in the meningeal sheaths of the optic nerve. The occurence of papilledema indicates that the intracranial pressure is freely transmitted to the optic nerve. When the patient is recumbent, intracranial pressure is normally between 6 and 15 mm Hg. In the upright position the pressure at the level of the optic nerves is likely to be substantially less. Variations, both normal and pathological, in the intracranial pressure are well documented. A diminution of the intracranial pressure will increase the pressure gradient across the lamina cribrosa just as effecively as a heightening of the intraocular pressure and might well explain the mysterious development of low tension glaucoma. Since it is the pressure differential between the intraocular and intracranial environments which ultimately determines the fate of the disc, one should at least consider the possibility that low tension glaucoma could be a disease where an abnormally high translaminar pressure gradient was caused not by increased intraocular tension but by an abnormal depression of the intracranial pressure.

As for the development of nerve fiber bundle defects in the visual field, it is well understood that although they are seen most commonly in glaucoma, their occurrence is by no means limited to that disease. The configuration of these scotomata reflects the disposition of fibers within the optic nerve, and any lesion from the chiasm to the disc that impairs the nerve function may be responsible for them. This is particularly true of arteriolar vascular lesions such as are thought to account for ischemic optic neuropathy. The apperance in an older person of a nerve fiber bundle defect in the presence of a flat optic nerve head and in the absence of elevated intraocular pressure is usually ascribed to vascular disease.

Inasmuch as intraocular pressure is normal by definition, and the field defects are relatively non-specific, it is the development of nerve head excavation in association with scotomata that is the sine qua non of low tension glaucoma. The excavation seen in low tension glaucoma is more likely to be shallow, with the formation of a sharp rim, and with the associated sharp bending of the vessels as they descend from the level of the retina to the floor of the shallow cup. As opposed to open angle glaucoma, the excavation is more likely to be asymmetrical, reaching the edge of the disc in one meridian while elsewhere a substantial rim of tissue remains intact. This picture of partial atrophy of the disc is not uncommon in the elderly, although in the absence of elevated tension it seldom leads to field loss, and thus does not fulfill the criteria of low tension glaucoma.

It is important to distinguish low tension glaucoma as it appears in the second half of life from a very different constellation of symptoms that is not uncommonly seen in children and adolescents. These young patients are found to have large deep excavations with baring of the lamina cribrosa, so that on first glance on fears to have detected a case of advanced juvenile glaucoma. But when one looks again one is reassured by seeing a pink, albeit thin rim of nerve fibers descending into the depths of the cup. No field defect is demonstrable, and on checking the pressure one notes with relief that it is on the low rather than the high side of normal. These young patients do not have and do not develop glaucoma. The sieve-like openings in the lamina cribrosa which are so clearly visible, associated with an unusually low intraocular pressure, suggest that perhaps in some patients the lamina cribrosa might not be impervious to fluid after all and that it might be worthwhile to study the hydrodynamic behavior of that tissue, particularly in the juvenile eye, without any preconceptions about its permeability.

Like many decisions in the therapy of glaucoma, the question of how to treat low tension glaucoma is fraught with difficulties. These problems reflect in part the obscurities of diagnosis. Patients in the age group in which the disease is prevalent not infrequently have a benign atrophy of the optic nerve head which, in the absence of field loss, cannot be distinguished from the early stages of low

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1679 Massachusetts Avenue
Cambridge, Mass. Ø2138

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tension glaucoma. They are prone to vasculopathies that can mimic glaucomatous field defects. We may be confident that our usual armamentarium of anti-glaucoma medications will be helpful in reducing a pressure of, for example, 34 mm Hg, but it is much less certain how large a pressure reduction can be achieved if the tension is no more than 12 or 13 mm Hg. to begin with. Even more important is the question in what proportion of eyes which are losing field, for example, at 13 mm Hg. reduction of pressure to 10 or even 8 mm Hg. will be effective in preserving the vision. At best we have only anecdotal data, and more often than not we proceed with treatment the basis of ill-defined hunches and theories.

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The problem receives its most poignant formulation when one is confronted with a patient in whom medication is ineffective in lowering an intraocular pressure which is statistically normal, but at which visual field continues to be lost. Shall we then stand by like helpless spectators to the race between blindness and death, or shall we assert our prerogatives of intervention, and, in the vernacular of our trade, "filter the patient", knowing full well that although if he is fortunate, we will save his sight, our well-intentioned attempt to do so may set in motion a series of events from which he could rapidly lose what little vision he has. The litany of complications of filtering surgery is well-known. The chamber goes flat and the choroid separates, the macula becomes edematous, a cataract forms, the lens is extracted, and then, if the patient is unfortunate the filtering bleb is lost, and a lengthy therapeutic effort will have been counterproductive.

Here if anywhere, it is necessary that the patient make the decision that determines his fate. For while he has the right to the benefit of every technical procedure that modern ophthalmology has to offer, he must also have the right to reject that technology, especially when it is fraught with such grave risks. The patient who refuses surgery under those circumstances denies the surgeon the opportunity of demonstrating his technical virtuosity, but at the same time gives the physician the chance to care for him nonetheless, and thereby to prove himself, what in the end is just as important, a kind and understanding and compassionate human being.

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