Nonarteritic anterior ischemic optic neuropathy (NAION) has been the subject of numerous publications and editorials. Yet, meaningful progress toward understanding the pathogenesis of this entity has been limited.2

As the term “ischemic” would indicate, investigators have focused their efforts on defending a vascular cause.3–5 What is the evidence for ischemia in this entity that, by histopathologic6–8 and observational ophthalmology, first affects the prelaminar optic disc? The fact that vascular abnormalities such as disc hemorrhages and swelling are present at the time of visual loss, followed by peripapillary vascular narrowing and ensuing disc pallor, is enticing, but not etiologically conclusive.

Unlike ischemic neuropathy in giant cell arteritis in which short posterior ciliary arteries are affected, with loss of supplied tissue leading to increased laminar cupping,9 such findings have never been demonstrated in NAION. Fluorescein and indocyanine green angiography demonstrate changes at the prelaminar disc surface alone, uncorrelated to changes in visual field or in neural tissue, and not at the deeper levels supplied by the ciliochoroidal and central retinal vasculature.10–12

Whiteness with disc swelling has been accepted as a sign of ischemia, but there is both optic disc and retinal evidence that such whiteness is indicative of axoplasmic stasis (cotton wool spots) that may also occur simply from anatomic distortion of axons.13–16 rather than occlusion of vessels.17,18 This may also occur from fracture of the axonal cytoskeleton and frank membrane disruption with axoplasmic “leakage.”

In giant cell arteritis, retrolaminar vascular occlusion will cause axoplasmic accumulation anteriorly, with a white appearance at the level of the optic disc.17,18 If disc ischemia were prelaminar, however, white axoplasmic accumulation and swelling would develop upstream predominately in peripapillary retina. The immediate development of prelaminar disc changes with the onset of clinical symptomsatology precludes slow orthograde axoplasmic accumulation as responsible.

The search for a systemic vascular denominator for this disease has been futile.19,20 With so little to show for it, it seems worth questioning the underlying presumption of ischemia as an etiologic factor for so-called NAION.

When the name of an entity itself may be a misnomer, it can be especially difficult to escape erroneous interpretations of pathophysiology. Indeed, the mechanism of this disease needs to be reanalyzed in a completely different direction.

Numerous examples exist of retinal damage accompanied by hemorrhages and other defects in response to spontaneous or surgical peeling of the vitreous and internal limiting membrane.6,21–24 Where vitreomacular attachments are present, microcystic changes can be noted in a nonvascular pattern.25–34 Disc tissues including the peripapillary area are also susceptible to vitreous separation, but the effect of such separation has, in years past, been neglected.

Traction and separation of the vitreous from an optic disc can alter its structure.35–37 A range of possibilities, from mere subclinical trauma to total axonal damage, can occur. Only fine basal lamina overlies the optic disc and thin-to-no internal limiting membrane over nearby vessels, with focal gaps in these membranes thus allowing for intimate and firm direct vitreo-glial-axonal and vitreovascular attachments.36–41

The flat disc with little or no cup, the so-called disc at risk,42 has fascinated investigators and is the substrate in which so-called NAION occurs. It must be important because it is so clearly associated with this entity,43,44 exceptions notwithstanding.45 Vitreopapillary attachments are firmer on cupless discs; the fine basal lamina has a thick layer of astrocytes overlying axons centrally46 and epipapillary membranes extend more broadly and firmly over parapapillary retina possessing focal gaps in its internal limiting membrane,36,37,39 whereas separation occurs more precociously in diabetic persons.47–49

In the age groups in which vitreous synchysis and partial detachment is noted,50–53 and in which so-called NAION also occurs, these are a spectrum of consequences of vitreopapillary traction and separation are now being recognized.

Transitory Sensory Phenomena

Vitreous tractional forces transmitted to photoreceptors may induce phosphenes,25,33,50,51 Via the vitreo-glial-axonal attachments that exist, vitreous detachment can also rupture glial cells.30,37,39,41,53 Electrolyte imbalances may then initiate a wave of depolarization via ephaptic transmission, with spreading depression a cause of amaurosis fugax.56,57 Vitreous traction can kink or distort axons to slow signaling with gaze-evoked amaurosis.59

Persistent Disc Elevation

Vitreopapillary traction can cause disc elevation49,60–63 and irregular dilatation of the surface vessels. Peripapillary traction also may persist through epipapillary membrane
attachments,\textsuperscript{36–39} which, when avulsed, appear as Weiss’s ring. Peripapillary photoreceptors may become dysfunctional or detached, giving rise to an enlarged blind spot. Such disc elevation may persist for long periods until the traction is resolved.

**Peripapillary Vascular “Fundal” or “Waistband” Narrowing**

Where internal limiting membrane is thinned or absent, particularly over disc vessels, vitreovascular attachments exist.\textsuperscript{37–47,64} Vitreous shearing and separation from blood vessels may be accompanied by damage to the vascular walls and leakage followed by reactive gliosis. These frequently overlooked changes occur most visibly within short segments of peripapillary arteries. The artery becomes constricted proximally, but is of normal diameter more distally. Such findings may be a diagnostic characteristic and hallmark of vitreovascular separation. This “fundal narrowing” with sheathing is its delayed effect, “footprints in the snow” of disturbed vitreovascular attachments.

**Pre-papillary Bleeding**

Vitreous separation also may cause tearing of vessels.\textsuperscript{16,21–24,39,65–68} This may occur through direct vitreovascular attachments or connections to disc and retinal tissues secondarily tearing capillaries. Such bleeding may be viewed as an epiphenomenon of vitreous detachment unassociated with loss of visual function,\textsuperscript{65–68} rather than the cause of axonal injury.

**Shear Force Injury to Axons Causing Visual Field Defects**

During surgical vitreous stripping maneuvers, injury to the disc, should it occur, is predominantly on the nasal aspect where epipapillary membranes are thickest and most firmly attached.\textsuperscript{36–38} Often causing temporal and altitudinal visual field defects that do not follow a pattern of retinal vascular occlusions.\textsuperscript{21,22,24,67,69} Spontaneous posterior vitreous detachments, on the other hand, are most likely to course through the top of the disc and from its temporal aspect, and progress downward.\textsuperscript{26,41,50,65,68} They may occur over minutes to hours often during rotational eye movements\textsuperscript{35,26,41} while awake or during rapid eye movements while asleep. Such vitreous dissection may momentarily be arrested while awake or during rapid eye movements while asleep. Areas with vitreous tension may be disclosed via the irregular dilatation of fine surface vessels correlating to areas of visual field sparing,\textsuperscript{79} adjacent to sections damaged through vitreous separation. Release of residual vitreous attachments with unkinking of axons can explain slight visual recovery,\textsuperscript{3} as well as resolution of surface telangiectasias.

We welcome efforts using optical coherence tomography,\textsuperscript{81–82} and other modalities such as dynamic B-scan ultrasonography to further clarify the role of vitreous separation in mechanical dynamic stretch injury to a “disc at risk.” We have discussed why “NAION” may be a pervasive and tenacious misnomer. It needs to be renamed as a papillary vitreous detachment neuropathy, such as PVD-N, and would be more properly understood as an extreme outcome within the spectrum of vitreopapillary separation disorders. In those at risk,\textsuperscript{49,83} the timely and controlled release of vitreous connections to the optic disc may preempt such jarring finale.

Once separation is arrested, gial and axoplasmic “leakage” from disrupted neural tissue and blood released from torn capillaries with the ensuing inflammatory response results in structural and atrophic changes that may weaken the remaining attachments.

Although a stepwise progression of vitreous detachment\textsuperscript{8,41,53,64} and loss of visual function with “progressive NAION”\textsuperscript{78} is still possible, the most likely outcome is slowed and uneventful progression of vitreous detachment or, alternatively, indefinite partial attachment where epipapillary membranes remain adherent to the optic disc. Areas with vitreous tension may be disclosed via the irregular dilatation of fine surface vessels correlating to areas of visual field sparing,\textsuperscript{79} adjacent to sections damaged through vitreous separation. Release of residual vitreous attachments with unkinking of axons can explain slight visual recovery,\textsuperscript{3} as well as resolution of surface telangiectasias.

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**References**

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