

Glaucoma Update

Cupping vs Sinking

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Cupping Optic Disc Paradigm

1. In cupping disc paradigm the optic disc is assumed to be a fixed structure in the scleral canal similar to corneo-scleral junction. Therefore it is assumed that the high IOP can only enlarge or excavate the physiological cup (original cup) without displacing the disc in the scleral canal.
2. Physiological cup is enlarging concentrically as a result of high IOP known as cupping.
3. In cupping the lamina cribrosa is believed to be primary site of injury.
4. Cupping implies that axons are atrophied due to compression of the axons in the holes of the lamina cribrosa due to high IOP.
5. In cupping the excavation is believed to be compression of the axons and glial tissue.
6. If cupping were occurring, the central vision fibers because of their central and superficial location (closer to vitreous) should be destroyed first, but this is not occurring.
7. Cupping of the disc implies that pathology starts from the central part of the disc and extends to the peripheral part of the disc.
8. If cupping is caused by high IOP then we should be able to halt the disease by lowering of IOP.
9. Cupping of the disc can't explain higher incidence of glaucoma in myopia.

Sinking Optic Disc Paradigm

1. Optic disc is not a fixed structure in the scleral canal like corneo-scleral junction. Optic disc is separated from the scleral edge/rim by the circular border tissue of Elschnig which acts as a 'O' ring seal. Due to atrophy of the border tissue the disc becomes loose and starts sinking.
2. Physiological cup is not truly enlarging but breaking up or de-cupping.
3. In sinking disc the circular border tissue of Elschnig is believed to be site of injury.
4. Sinking of the disc implies that pre-laminar axons prior to their entry into lamina cribrosa are being severed against the scleral edge.
5. In sinking disc, the excavation is due to creation of empty space as a result of severing and depletion of the axons.
6. Sinking of the disc implies that peripheral vision axons, because of their deeper location (closer to sclera) should be destroyed first and this is exactly what occurring in glaucoma.
7. Sinking of the disc implies that the pathology starts from the deep peripheral fibers and finishes at the central axons and this fact is supported by the visual fields, that the peripheral fields are destroyed first and central at the end.

We can't halt the disease if optic disc is sinking despite maximally lowering of IOP because sinking disc becomes a mechanical problem like herniation.

8. Sinking of the disc can explain higher incidence of glaucoma in myopia due to thinness/stretching of the border tissue due to enlarged myopic eyeball.
9. Sinking of the disc can explain nasal shifting of the blood vessels due to loss of anchorage from severance of the temporal axons more so than the nasal axons due to usual temporal tilt of the disc. **Analogy:** If roots of a tree are severed from one side the tree is shifted to opposite side.

10. Cupping occurring concentrically can't explain nasal shifting of the central blood vessels.
11. Cupping of the disc implies that IOP is the sole cause of excavation of the optic disc either due to high levels of IOP or due to undue sensitivity of the disc to even normal range IOP.

Cupping implies that axons are being compressed and atrophied in lamina cribrosa but this is not supported by the histology of the glaucomatous disc.
12. If the cupping is occurring then those born with large physiological cups such as 0.8 will become blind sooner since they are already 80% cupped to start with.
13. In cupping it is hypothesized that arcuate axons are selectively destroyed due to presence of different size holes in the lamina cribrosa. As the lamina cribrosa bows backward due to high IOP there is distortion of the holes in the laminal sheets resulting in pinching of the axons and interfering of the axoplasmic flow.
14. Cupping phenomenon of the optic disc is not supported by the histology of the end-stage glaucomatous disc.
10. Sinking of the disc can explain glaucoma being a multifactorial disease since multiple systemic factors can affect the oxygenation and nutrition of the border tissue.
11. In sinking disc the axons are being severed, histology of the intermediate stage glaucomatous disc reveals segmental disappearance of the axons in the compartments previously occupied by the axons. Empty compartments get filled with mucoid material. Presence of empty compartments indicate that axons are being severed and not atrophied. (*Ref: Ophthalmic Pathology* by Hogan and Zimmerman. Second edition P 627)
12. If disc is sinking then size of physiological cup does not influence in the progression of glaucoma
13. In sinking disc the arcuate axons are selectively destroyed because of their fewer number compared to the macular axons. All the temporal axons consisting of superior, inferior arcuate and centrally located macular axons are being severed simultaneously. However since the arcuate axons being fewer in number will be depleted earlier resulting in arcuate field defects.
14. Histology of the end-stage glaucomatous disc reveals an empty crater. There are no axons and no lamina. Why do we call end-stage 100% cupped disc when optic disc is no longer present.

