10.4.1. Open Angle Glaucoma (I): Primary Open-Angle Glaucoma

- Clinical Features
  - insidious onset
  - slow progression
  - painless
  - usually bilateral
    - ± asymmetric
- Gonioscopic findings
  - gonioscopy should be performed
    - in all patients evaluated for glaucoma
    - periodically in patients with established open-angle glaucoma (OAG)
    - when the chamber becomes shallow
    - when strong miotics are prescribed
    - after laser trabeculoplasty or iridotomy
    - when IOP rises
- Intraocular pressure
  - IOP distribution in the general population
    - mean IOP=15.5 mm Hg
    - standard deviation=2.6 mm Hg
    - mean IOP ± 2 standard deviations = 10–21 mm Hg
  - definition of IOP >21 mm Hg as "abnormal" has a number of shortcomings
    - IOP in the general population is not represented by a Gaussian distribution but is skewed toward higher pressures
    - IOP distribution curves in glaucomatous and nonglaucomatous eyes show a great deal of overlap
    - 30%–50% of individuals with glaucomatous optic neuropathy and/or visual field loss have initial screening IOPs below 22 mm Hg
  - diurnal fluctuation of IOP
    - patients with glaucoma
    - patients without glaucoma
      - 2–6 mm Hg
    - most individuals demonstrate similar fluctuation patterns from day to day
      - 10%–20% of patients are "erratic"
    - single measurements of IOP during office hours do not adequately depict the degree of fluctuation of IOP
    - spontaneous asymmetric fluctuations of IOP between fellow eyes occur commonly in individuals without glaucoma and in glaucoma patients
    - large diurnal IOP fluctuation has been identified as an independent risk factor for progression of glaucoma
    - shift from upright posture during the day to supine posture at night may be associated with increased nocturnal IOP measurements
      - peak IOP in early morning hours while still in bed
    - because of diurnal fluctuation, elevations of IOP may occur only intermittently in some glaucomatous eyes
      - ≤1/3 of the measurements are normal
  - alcohol decreases IOP
  - corneal thickness
    - average corneal thickness in adults
      - 530–545 μm
    - persons of African ancestry have lower mean CCT
    - thicker corneas resist the indentation, resulting in artificially high measurements
    - true IOP in eyes with lower CCT is higher than that measured by Goldmann tonometry
    - lower CCT has been found to be an important risk factor for progression of ocular hypertension to glaucoma
    - among patients with OAG, lower CCT is a risk factor for disease progression
  - elevation of IOP is a strong risk factor for glaucoma progression
  - agents increasing IOP
    - LSD
    - ketamine
  - agents decreasing IOP
    - heroin
    - alcohol
      - HAC
    - cannabis
- Optic disc appearance and visual field loss
  - diagnosis of POAG is based primarily on
    - appearance of the optic disc
    - performance on visual field testing
      - visual field loss should correlate with the appearance of the optic disc
        - significant discrepancies in the pattern of field loss and optic nerve damage warrant additional investigation
- Risk Factors for POAG Other Than IOP
  - advanced age
    - prevalence of glaucoma increases dramatically with age (particularly among black persons)
      - 11% in those 80 years or older
    - visual field defects were 7 x more likely to progress in patients ≥60 years than in those ≤40 years
    - studies in Japan have shown a relationship between glaucoma and age even with no increase in IOP
      - age appears to be an independent risk factor for the development of glaucoma
  - race
    - prevalence of POAG is 3-4 x greater in black and Hispanic persons
    - blindness from glaucoma is ≥4 times more common in blacks
    - glaucoma is more likely to be diagnosed at a younger age and to be at a more advanced stage at the time of diagnosis in black patients
  - positive family history
    - relative risk of POAG is increased ≈ 3.7x for individuals who have a sibling with POAG
- Prognosis
  - most patients with POAG will retain useful vision for their entire lives
  - prevalence of bilateral blindness among persons with OAG
    - 8% in black persons
    - 4% in white persons
  - patients at greatest risk of blindness have visual field loss at the time of diagnosis of glaucoma
  - treatment with medication, laser surgery, or incisional surgery to lower IOP has been shown to significantly reduce the risk of progression of the disease
  - ***Early Manifest Glaucoma Trial (EMGT)***
    - mean IOP reduction of 25% reduced the risk of progression of OAG from 62% to 45% of patients at 6 years' follow-up
  - ***Collaborative Initial Glaucoma Treatment Study (CIGTS)***
    - medical therapy was essentially equally as effective as surgical therapy in preventing POAG progression
    - initial medical therapy and initial surgical therapy for OAG resulted in relatively equivalent outcomes after 5 years
    - significant visual field progression in only 10%–13%
- Associated Disorders
  - **myopia**
    - association between POAG and myopia
    - Beaver Dam Eye Study
      - myopia (≥–1 D spherical equivalent) was a significant risk factor for glaucoma prevalence
    - Rotterdam follow-up study
      - high myopia (≥–4 D spherical equivalent) was associated with a hazard ratio of 2.31 for the development of incident glaucoma
    - concurrence of POAG and myopia may complicate diagnosis
      - evaluation of the optic disc is complicated in highly myopic eyes that have tilted discs or posterior staphylomas
      - magnification of the disc associated with the myopic refractive error interferes with optic disc evaluation
      - myopia-related retinal anomalies can cause visual field abnormalities
      - high refractive error may make it difficult to perform accurate perimetric measurement and to interpret visual field abnormalities
  - **diabetes mellitus**
    - controversy as to whether diabetes is a risk factor for glaucoma
      - Beaver Dam Eye Study
        - association between diabetes and OAG
      - Blue Mountains Eye Study
        - association between diabetes and OAG
      - Los Angeles Latino Eye Study
        - association between diabetes and OAG
      - Framingham Study
        - did not find significant association between diabetes and OAG
      - Baltimore Eye Survey
        - did not find significant association between diabetes and OAG
      - Barbados Eye Study
        - did not find significant association between diabetes and OAG
      - revised analysis of the Rotterdam Study
        - did not find significant association between diabetes and OAG
      - OHTS
        - diabetes was associated with a reduced risk of glaucoma development
        - patients with any retinopathy were not enrolled in the trial
    - references
  - **blood pressure**
    - systemic hypertension was associated with
      - lower risk of glaucoma in younger (<65 years) subjects
        - higher blood pressure --> improved perfusion of the optic nerve
      - increased risk of glaucoma in older subjects
        - chronic hypertension --> increases optic nerve's susceptibility to the development of glaucomatous optic neuropathy
      - Baltimore Eye Survey
      - Barbados Eye Studies
        - relative risk of incident glaucoma among subjects with systemic hypertension was <1.0 in all age groups
    - ocular perfusion pressure
      - = blood pressure (systolic, diastolic, or mean arterial) minus IOP
      - lower ocular perfusion pressure is a strong risk factor for the development of glaucoma, independent of IOP
      - overtreatment of systemic hypertension may be a contributing factor to glaucoma progression
    - references
  - **retinal vein occlusion**
    - after CRVO (hemicentral retinal vein occlusion), patients may develop angle-closure glaucoma or, at a later stage, neovascular glaucoma
    - glaucoma and OHT are risk factors for the development of CRVO (hemicentral retinal vein occlusion)
    - OHTS
      - occurrence of vein occlusions was higher in observation group than in treatment group
    - consideration should be given to treating elevated IOP in patients with a history of CRVO
      - to reduce the risk of CRVO in the fellow eye
  - **other associated conditions**
    - sleep apnea
    - thyroid disorders
    - hypercholesterolemia
    - migraine
    - Raynaud phenomenon

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