Imaging the Pathology of Diabetic Retinopathy

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Type 1 diabetes (Juvenile)
- Insulin dependent diabetes due to the pancreas not producing enough insulin to allow sugar into cells to produce energy
- Causes include genetics, viral infection, autoimmune issues
- Can develop in adults
- Affects major organ systems when sugars out of control

Type 2 (Adult onset)
- Affects metabolism of sugar
- Insulin resistance, cells do not respond to insulin
- Inadequate insulin production
- Glucose not maintained at correct level

Type 2 risk factors
- Overweight/obesity
- Body fat distribution (35 inch waist circumference in women, 40 inch in men)
- Family history of parent or sibling with Type 2
- Race. Higher incidence in black, Hispanic, Native American and Asian populations
- Age. Increased risk in those 45 and older. Numbers are growing in children, adolescents and young adults.
### Type 2 risk factors (continued)
- Prediabetes
- Polycystic Ovarian Syndrome (PCOS)
- Acanthosis Negrans (darkening of skin in armpits and neck indicating insulin resistance)

### Diabetic Complications
- Diabetes is disease of blood vessels
- Nerve damage which is secondary to small vessel damage. Includes lower extremities/feet and hands (diabetic neuropathy).
- GI tract (Gastroparesis)
- Erectile dysfunction in men due to small vessel disease
- Kidney failure. Small vessel damage causes kidneys to be unable to filter waste

### Diabetic Complications (cont.)
- Non healing foot ulcers which can become infected and lead to limb loss
- Pregnancy issues causing miscarriage, stillbirth, birth defects and increased birth weight
- Pregnant women have increased risk of DKA, retinopathy and pre-eclampsia. Gestational diabetes does not carry same risks.
- Diabetic eye disease

### Eye Disease in Diabetics
- Non-proliferative diabetic retinopathy (NPDR)
  Previously referred to as background diabetic retinopathy (BDR)
- Proliferative Diabetic retinopathy
- Diabetic macular edema
- Cataracts
- Glaucoma
- Diabetic papillopathy
Non-proliferative Diabetic Retinopathy (NPDR)

Mild NPDR
- Microaneurysms only
- Followed annually

Moderate NPDR
- Less than 4/2/1 rule
- Microaneurysms
- Dot/blot hemorrhages
- Flame hemorrhages
- Hard exudates
- Cotton Wool Spots
- Venous beading
- Intraretinal microvascular abnormalities (IRMA)

Severe NPDR
Severe NPDR
Follows 4/2/1 rule
• 20+ microaneurysms in all four quadrants (4)
• Venous beading in 2+ quadrants (2)
• IRMA in 1+ quadrants (1)
Ischemia (dropout of blood vessels)

- Microvascular damage causes vessels to die
- Cannot be treated
- Creates the drive for neovascularization
- Most noticeable if in macula with enlarged foveal avascular zone (FAZ)
Ischemia

Proliferative Diabetic Retinopathy (PDR)
- Neovascularization
- Preretinal or vitreous hemorrhage
Diabetic Macular Edema

- Can occur at any stage of retinopathy from mild NPDR to PDR
- Result from leakage into macula
Cataracts

- Higher incidence in diabetics
- Related to sugar elevation
Glaucoma

- Neovascular glaucoma associated with PDR and neovascularization into angle

Imaging of NPDR

Microaneurysms (MA’s)

- Appear as small red dots
- Outpouchings of capillaries
- Can be reversible with better blood sugar control
- May cause no problems or vision issues
- Can leak, causing edema, which is significant if in macula
- Best seen on angiography
Imaging of NPDR
Dot/Blot hemorrhages
• Occur as microaneurysms rupture in the deeper layer of retina
Imaging of NPDR
Flame hemorrhages

- Splinter type hemorrhages
- Occur in nerve fiber layer
Imaging of NPDR
Hard exudate
• Caused by break down of blood-retina layer which causes leakage of proteins and lipids
• Appear in ring like pattern surrounding end of vessel
Imaging of NPDR
Cotton wool spots (CWS)
• Nerve fiber layer infarctions from precapillary arterioles
• Appear white and fluffy like cotton
• Show up on angiography as area of non-perfusion (ischemia)
• Frequently bordered by MA’s

Imaging of NPDR
Venous loops
• Occur adjacent to areas of ischemia
• Significant predictor of progression to PDR
Imaging of NPDR

Venous beading

• Areas of dilation and constriction of veins
• Sausage link or bead like appearance
• Significant predictor of progression to PDR

IRMA

• Remodeled capillary beds
• They are essentially shunt vessels to supply blood to areas of ischemia
• Found in areas with adjacent ischemia
• Are sometimes confused with neovascularization
• IRMA is larger in caliber and does not leak on FA
Diabetic Macular Edema

- Leading cause of visual impairment in diabetics
- Can be found at any stage of retinopathy from mild NPDR to PDR
- Can be non-central or central
- Treated with focal laser, micropulse laser, Anti-VEGF, steroids
Diabetic papillopathy

- Optic nerve swelling, many times with good vision.
- Exact etiology unknown, possibly associated with retinal vascular leakage or microvascular disease of microvasculature of optic nerve head.
- Small cup may increase risk slightly.
- Spontaneous resolution occurs within few months.

Diabetic papillopathy (cont)

- Resolution results with no resulting atrophy or decrease in vision.
- Can indicate a rapid progression of retinopathy and NVD.
- Promising results obtained with Avastin and steroid injections to speed up recovery.
Imaging PDR
Neovascularization

• Common on optic nerve (NVD)
• Common within 3 DD of major retinal vessels
• Ischemia occurs and retinal cells respond by releasing vascular endothelial growth factor (VEGF) due to high metabolic demand of retina.
• New vessels grow to bypass damaged vessels and nourish retina
• New vessels are leaky, fragile and grow into vitreous

PDR

• Preretinal hemorrhages occur with bleeding between retina and hyaloid membrane
• Blood is trapped between under membrane and spreads out like water between two glass panes
Vitreous hemorrhage

- Occurs when blood has broken through the hyaloid membrane and is into vitreous cavity
- Body can sometimes clear it
- Vitrectomy is solution for non-clearing hemorrhages

Neovascularization of iris

- Occurs in with PDR when neovascularization occurs on iris
- Also referred to as rubeosis
- Can also occur with vascular events such as artery or vein occlusions
Neovascularization of angle

- Neovascular growth into trabecular meshwork causing neovascular glaucoma
- If IOP can be lowered with pharmaceuticals, can be treated with anti-VEGF.
- Sometimes need glaucoma specialist and surgical intervention to lower IOP
Tractional retinal detachment (TRD)
- Occurs when neovascularization grows into vitreous.
- Traction of vessels pulls retina up like tent
PDR treatments

• Treated with PRP
• Sometimes anti-VEGF medications are used prior to panretinal photocoagulation (PRP) with bleeding or if patient has persistent hemorrhaging despite PRP
• PRP destroys peripheral retina to decrease overall metabolic need/demand for nutrients. This will lower chance of neovascularization and associated complications