EyePACS Grading System (Part 2): Detecting Presence and Severity of Background (Non-Proliferative) Diabetic Retinopathy Lesion

George Bresnick MD MPA
Jorge Cuadros OD PhD
Anatomy of the eye:
Normal Retina

Retinal Arcades

Macula

Optic Nerve
EyePACS Digital Retinal Image Grading System

DIABETIC FUNDUS LESIONS REFLECT:
Abnormalities of retinal microvasculature
- Ischemia (capillary/arteriolar closure)
- Abnormal permeability (capillary leakage)

Lesion type and severity
- predict risk for future vision loss
- thereby, determine need and urgency for referral
This presentation will emphasize:

- Appearance and pathophysiology of retinal lesions

**FUNDUS LESIONS AND THEIR ORIGINS**

- Natural history of diabetic retinopathy

**WHAT HAPPENS TO UNTREATED EYES?**

- Treatment results (DRS/ETDRS)

**HOW DO TREATMENT GUIDELINES INFLUENCE GRADING PROGRAM?**
**EyePACS Grading Template**

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<td>Yes</td>
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**Other referrable conditions in either eye:**
- Cataract
- Glaucoma
- Occlusion
- Maculopathy
- Other
Diabetic Retinopathy
Pathophysiology

Nonproliferative Diabetic Retinopathy (NPDR)
“background changes” within the retina

- Retinal vessel closure (retinal ischemia)
  - Capillary closure-mild retinal ischemia
  - Arteriolar closure-more severe retinal ischemia

- Increased retinal vessel permeability (and macular edema)
RETINAL CAPILLARY CLOSURE

Mild retinal ischemia

**FLUORESCEIN ANGIOGRAPHY**

Two processes:

- Capillary *nonperfusion* (closure)
- Compensatory capillary *dilation*, including microaneurysms
Fluorescein angiogram
Normal macula

Normal capillaries barely visible
Fluorescein angiogram
Diabetic macula

Dilated capillaries interspersed with Nonperfused dark spaces and hyperfluorescent dots (microaneurysms)
Normal Retinal Capillaries
Trypsin Digest

Regular capillary caliber
Round dark pericytes; elongated endothelial nuclei
Diabetic Retinal Capillaries
Trypsin Digest

Acellular (nonperfused) capillaries
Hypercellular (dilated) capillaries
Fundus Lesions Associated with *Capillary* Closure

**Microaneurysms (MA)**

**Appearance:**
- Small red dots 20-125 microns in diameter

**Location**
- Clustered adjacent to areas of capillary nonperfusion

**Significance**
- Earliest manifestation of diabetic retinopathy
- Numerous MA indicates widespread capillary closure
Fundus Signs of *Capillary* Closure

Microaneurysms
India Ink injection preparation of autopsy eye

Microaneurysms face into areas of capillary nonperfusion
MICROANEURYSMS ONLY (MA) → Mild Nonproliferative retinopathy

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Mild Nonproliferative Retinopathy (NPDR) = MICROANEURYSMS ONLY (MA)

- MA defined as small circular red dots with well-defined borders
- Patients with Mild NPDR usually **do not** require referral to eye care specialist.
- MA may resolve in about 2 years. MA turnover rate may indicate severity of diabetes.
NPDR: RETINAL ARTERIOLAR CLOSURE

More severe retinal ischemia

FLUORESCEIN ANGIOGRAPHY

- “Nipped” arteriolar side branches
- Non-perfused zone of capillaries in distribution of occluded arterioles
Arteriolar nonperfusion

Large dark nonperfused areas (Arrows)
“Nipped” arteriole branches (Circled)
Arteriolar nonperfusion

Large dark area below major arteriole apparently nonperfused. (Circled)
Arteriolar Occlusion

“Nipped” arteriolar branch (Arrow)
Acellular capillaries in distribution of arteriole (Circled)
Fundus Lesions Associated with Arteriolar Closure (ISCHEMIC RETINAL LESIONS)

- Cotton wool spots (CW)
- Venous beading (VB)
- Intraretinal microvascular abnormalities (IRMA)
- Dark, blot hemorrhages
Cotton wool spots (CWS)

Fluffy white "exudates" (Arrows)
Ischemic infarct nerve fiber layer.
Cotton Wool Spots
Faint CW spots nasal to disc and inf. nasal

Case 47492
HEMORRHAGES WITH OR WITHOUT MICROANEURYSMS (HMA): Moderate or Severe NPDR Depending on Location and Severity

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Other referrable conditions in either eye: Cataract □ Glaucoma □ Occlusion □ Maculopathy □ Other □
Distinguish $H$ (circled) from MA (box) 

H are larger or more irregular than MA 

Case 584
GRADING GUIDELINES:
Definition of Hemifields

- EyePACS images can be divided into superior and inferior hemifields by a horizontal line through the center of the optic disc.
- Used for comparison of EyePACS images with ETDRS Standard Photos
  - e.g., HMA>=Standard photo 2A in both superior and inferior hemifields?
HEMIFIELDS:

Each imaging field can be divided horizontally into **superior** and **inferior grading** hemifields.
HEMORRHAGES WITH OR WITHOUT MA (HMA)

- Consider all intraretinal “red spots” together (both hemorrhages and microaneurysms)

If present, mark the appropriate box:

<2A ( ) >=2A ( )

- Compare density and areal extent of HMA in the EyePACS images with density and extent of HMA in Standard Photo 2A.
  (See Photo 2A next slide.)

- Answer HMA>=2A**, if HMA >=2A in both upper and lower hemifields
- Answer HMA < 2A, if HMA are <2A in one or both hemifields,
HMA>=2A
HMA≥2A

Case 45164
HMA<2A in both hemifields
HEMORRHAGES WITH OR WITHOUT MA (HMA)

- If HMA greater than Image 2a in both hemifields:
  - then patient has severe nonproliferative retinopathy and requires referral to eye care specialist within 3 months.
  - associated with 48% chance of developing dangerous new blood vessels (neovascularization) within one year.

- If HMA is less than Image 2a in either hemifield then patient has Moderate NPDR and should be imaged again in 6 months.
Fundus Lesions Associated with Arteriolar Closure (ISCHEMIC RETINAL LESIONS)

- Cotton wool spots (CW)
- Venous beading (VB)
- Intraretinal microvascular abnormalities (IRMA)
- Dark, blot hemorrhages
DEFINITE VENOUS BEADING (VB) = Severe NPDR

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Other referrable conditions in either eye: Cataract Glaucoma Occlusion Maculopathy Other
VENOUS BEADING (VB) = Severe NPDR (depending on severity)

- Consider definite sausage-like dilation of one or more venous segments anywhere in the EyePACS images.

- Use Standard Photo 6A for examples of definite VB (See next slide.).

- Needs to be accompanied by other signs of ischemia
Venous Beading (VB)

Segmental dilation of vein, often adjacent to cotton wool spots
Venous Beading

Case 50603
VENOUS BEADING (VB) = Severe NPDR (depending on severity)

- If Venous beading is present and greater than reference image 6a, then patient has Severe NPDR and requires referral within 3 months to eye specialist.

- Venous beading greater than 6a is associated with a 51% chance of developing dangerous new blood vessels (neovascularization) within one year.
Fundus Lesions Associated with Arteriolar Closure (ISCHEMIC RETINAL LESIONS)

- Cotton wool spots
- Venous beading (VB)
- Intraretinal microvascular abnormalities (IRMA)
- Dark, blot hemorrhages
Question 6
INTRARETINAL MICROVASCULAR ABNORMALITIES (IRMA)?

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Other referrable conditions in either eye: Cataract Glaucoma Occlusion Maculopathy Other
INTRARETINAL MICROVASCULAR ABNORMALITIES (IRMA): Moderate or Severe NPDR

**Intraretinal microvascular abnormalities present?**
- no ( )
- yes ( )
- Cannot grade ( )

- Consider dilated tortuous capillary segments.

If (yes), mark the appropriate box:
- <8A ( )
- >=8A ( )

- Compare the density and severity of IRMA in EyePACS images with extent of IRMA in Standard Photo 8A. (See next slide.)
- Answer <8A, if IRMA <8A wherever present.
- Answer IRMA>=8A, if IRMA >=8A anywhere in the EyePACS images.
Intraretinal Microvascular Abnormalities >= 8a
Intraretinal Microvascular Abnormalities (IRMA)

Dilated tortuous capillary segments
Intraretinal Microvascular Abnormalities (IRMA)

Dilated tortuous capillary segments
IRMA > 8a

Case 47492
INTRARETINAL MICROVASCULAR ABNORMALITIES (IRMA)

- If IRMA is greater than Image 8a in either hemifield:
  - then patient has severe nonproliferative retinopathy and requires referral to eye care specialist within 3 months.
  - associated with 44% chance of developing dangerous new blood vessels (neovascularization) within one year.
- If IRMA is less than Image 8a then patient has Moderate NPDR and should be imaged again in 6 months.
# High-Risk Markers for Progression to Proliferative Retinopathy:

## Early Treatment of Diabetic Retinopathy Study

- **Extensive retinal hemorrhages (HMA)**: 48%
- **Venous beading (VB)**: 51%
- **Intraretinal Microvascular Abnormalities (IRMA)**: 44%
- **Cotton Wool Spots (CWS)**: No sig. increase
Severe Nonproliferative Retinopathy (NPDR)

Latin American male, DM II X 12 years, Last eye exam 5 years ago
Severe Nonproliferative Retinopathy (NPDR)

Latin American male, DM II X 12 years, Last eye exam 5 years ago

HMA > 2a
CW
60 yr. old, DM X 9yrs, HbA1C=9.1

1 yr. later, HbA1C=5.5:
33 yr. old Latin American male

- Type II DM X 5 years
- Hyperlipidemia
  - HDL/LDL: 46.2/143.3
  - Triglycerides: 321
- HbA1c = 11.9
- Meds: Lantus, Novolog, Pravachol
- Last Eye Exam: 2-5 years ago
33 yr. old Latin American male

- Microaneurysms
- Intraretinal hemorrhages
48 yr. old Pacific Island female

- Hypertension
- DM II Dx’s 11/2004
- HbA1c 9.3
- Cholesterol 223
- Triglycerides 216
- HDL 29
- Meds: Amlodopine, Toprol, Novolog, Lantus, Pravastatin
48 yr. old Pacific Island female

- CW
- HMA
- IRMA
- VB
NPDR Summary:

- Identifying presence and severity of retinal lesions associated with diabetes can help with triage and patient education:
  - No apparent diabetic retinopathy and HbA1c < 7: return in 2 years for imaging
  - Mild NPDR or HBA1c > 7: return in 1 year for imaging
  - Moderate NPDR: return in 6 months for imaging
    - HMA < 2a, CWS, or IRMA < 8a
  - Severe NPDR: refer to eye specialist within 3 months
    - HMA > 2a, VB, or IRMA > 8a
Thank You!

www.eyepacs.com
contact@eyepacs.com
800-228-6144