DM Retinopathy Screening Grading System and Cases Sharing

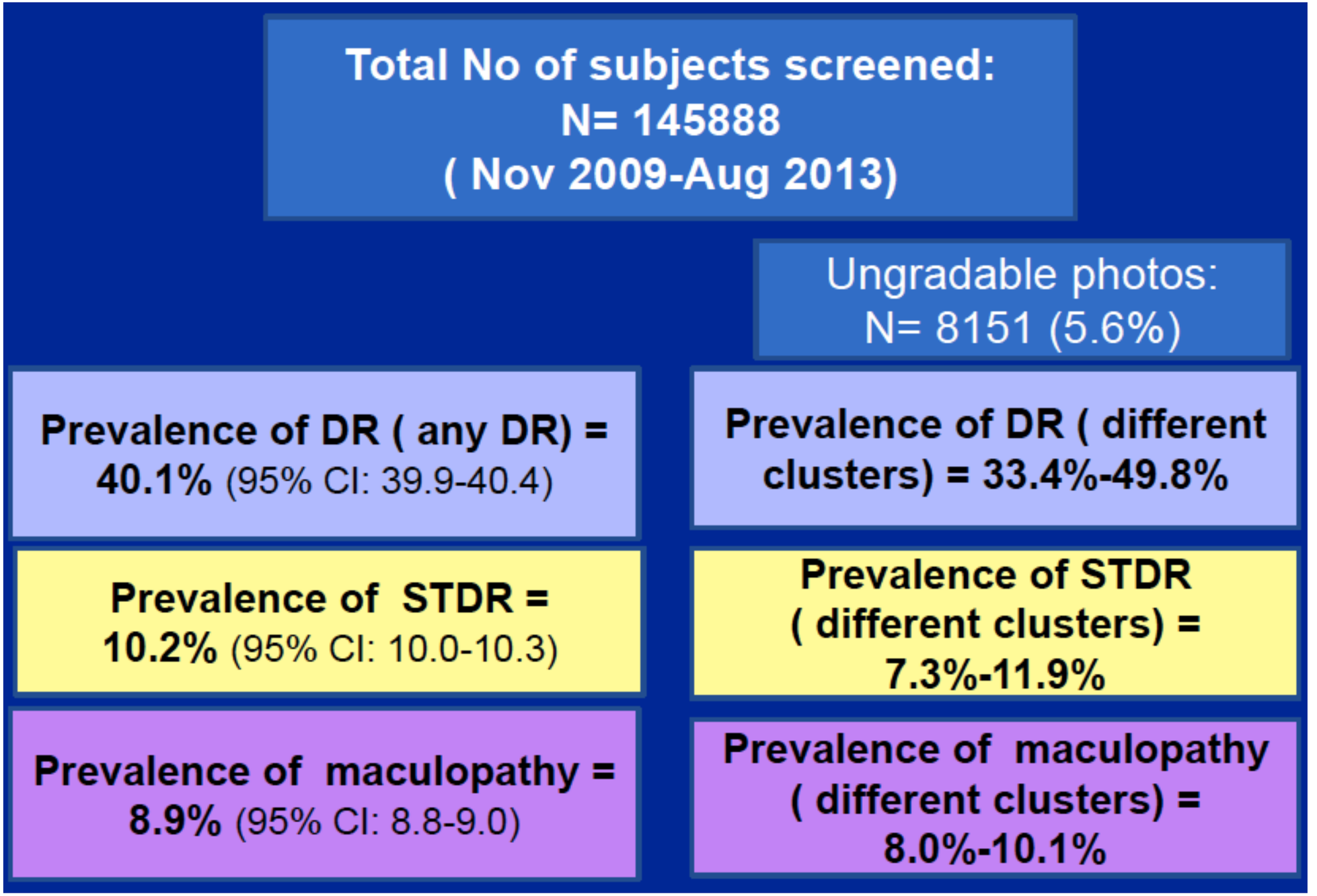
Fanny Yip
Associate Consultant, Hong Kong Eye Hospital

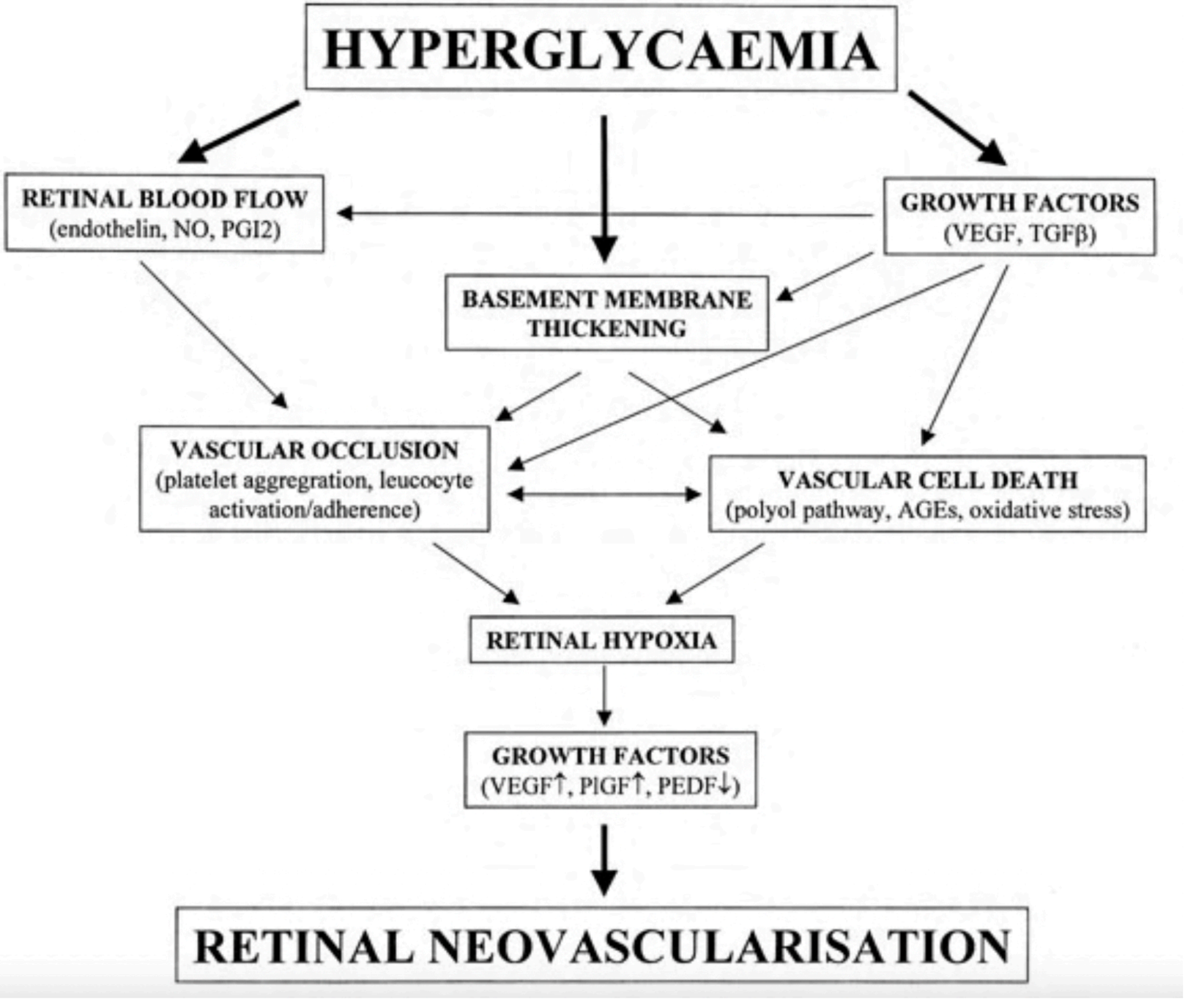
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Epidemiology

- The number of people with diabetes has risen from 280 million in 2010 to 347 million in 2014 [1,2]
- 10% population in HK [3]
- Diabetic retinal complications are the leading cause of blindness amongst working-age diabetics
- 2.6% blindness attributable to diabetes[4] (up to 3 million cases each year [5])
- Overall prevalence of 34.6% for any DR amongst which 10.2% was vision-threatening [6]

1. Gakidou E, Mallinger L, Abbott-Klafter J, et al. Bulletin of the World Heath Organization. Management of diabetes and associated cardiovascular risk factors in seven countries: a comparison of data from national health examination surveys. Available from: http://www.who.int/ bulletin/volumes/89/3/10-080820/en/#. Accessed 22 Oct 2015.
2. World Health Organization. Diabetes programme: diabetes. Available from: http://www.who.int/diabetes/ en/. Accessed 13 Jan 2016.
3. International Diabetes Federation. IDF diabetes atlas 6th edition, 2013. Available from: http://www.idf.org/ diabetesatlas. Accessed 20 Aug 2015.
4. Causes of vision loss worldwide, 1990-2010: a systematic analysis. Bourne RR, Stevens GA, White RA, Smith JL, Flaxman SR, Price H et al. Lancet Global Health 2013;1:e339-e349
5. WHO World report on vision 2019
6. Meta-Analysis for Eye Disease (META-EYE) Study Group, Yau JW, Rogers SL, Kawasaki R, Lamoureux EL, Kowalski JW, et al. Global prevalence and major risk factors of diabetic retinopathy. Diabetes Care. 2012;35:556-64. Epub Feb 2012.


Total No of subjects screened:
N= 145888
(Nov 2009-Aug 2013)
Ungradable photos:
N= 8151 (5.6%)
Prevalence of DR (any DR) = 40.1% (95% CI: 39.9-40.4)
Prevalence of DR (different clusters) = 33.4%-49.8%
Prevalence of STDR = 10.2% (95% CI: 10.0-10.3)
Prevalence of STDR (different clusters) = 7.3%-11.9%
Prevalence of maculopathy = 8.9% (95% CI: 8.8-9.0)
Prevalence of maculopathy (different clusters) = 8.0%-10.1%


HYPERGLYCAEMIA
RETINAL BLOOD FLOW
(endothelin, NO, PGI2)
GROWTH FACTORS
(VEGF, TGFβ)
BASEMENT MEMBRANE
THICKENING
VASCULAR OCCLUSION
(platelet aggregration, leucocyte
activation/adherence)
VASCULAR CELL DEATH
(polyol pathway, AGEs, oxidative stress)
RETINAL HYPOXIA
GROWTH FACTORS
(VEGF↑, PlGF↑, PEDF↓)
RETINAL NEOVASCULARISATION

Risk Factors: Non-modifiable

- Duration of disease
  - <5 years of disease: 17-28.8%
  - >15 years of disease: 77.8-97.5% [1]
- Type I DM (insulin-dependent or juvenile type)
  - Type I DM for ≥ 20 years increased the risk of any DR by 2.7 times, PDR by 15 times, DMO by 5 times and vision-threatening DR by 8.7 times compared with type 2 DM for < 10 years [2]
- Age
  - Rarely start before puberty
- Genetics
- Gender (M>F)

1.Klein R, Klein BE, Moss SE, Davis M, DeMets DL. The Wisconsin Epidemiologic Study of Diabetic Retinopathy

2.Meta-Analysis for Eye Disease (META-EYE) Study Group, Yau JW, Rogers SL, Kawasaki R, Lamoureux EL, Kowalski JW, et al. Global prevalence and major risk factors of diabetic retinopathy. Diabetes Care. 2012;35:556-64. Epub Feb 2012.

Risk Factors: Modifiable

- Poor glycaemic control (HbA1C)
  - Diabetic Control and Complications Trial – intensive control reduced risk of retinopathy by 76% and slowed progression by 54%
  - However, sudden improvement in control may be associated with progression of retinopathy due to increase in serum insulin-like growth factor
- Other cardiovascular diseases – hypertension, dyslipidaemia, obesity
- Habits - physical inactivity, smoking
- Pregnancy
- Co-existing diabetic complications
  - Nephropathy

Wilson and Jungner classic screening criteria

1. The condition sought should be an important health problem. (DR is the leading cause of blindness amongst working age)
2. There should be an accepted treatment for patients with recognised disease. (laser and surgery)
3. Facilities for diagnosis and treatment should be available. (yes)
4. There should be a recognisable latent or early symptomatic stage. (NPDR)
5. There should be a suitable test or examination. (dilated fundal exam, fundus photos)
6. The test should be acceptable to the population. (non-invasive)
7. The natural history of the condition, including development from latent to declared disease, should be adequately understood. (yes)
8. There should be an agreed policy on whom to treat as patients. (yes)
9. The cost of case-finding (including diagnosis and treatment of patients diagnosed) should be economically balanced in relation to possible expenditure on medical care as a whole.
10. Case-finding should be a continuing process and not a “once and for all” project.

WHO- screening of disease

The WHO recommends that screening should be done for any condition that is an important health problem, has an effective treatment that can be delivered early, usually before symptoms of the condition are apparent, when facilities for diagnosis and treatment are available, when screening is feasible and cost-effective, and when subjects can be followed up longitudinally

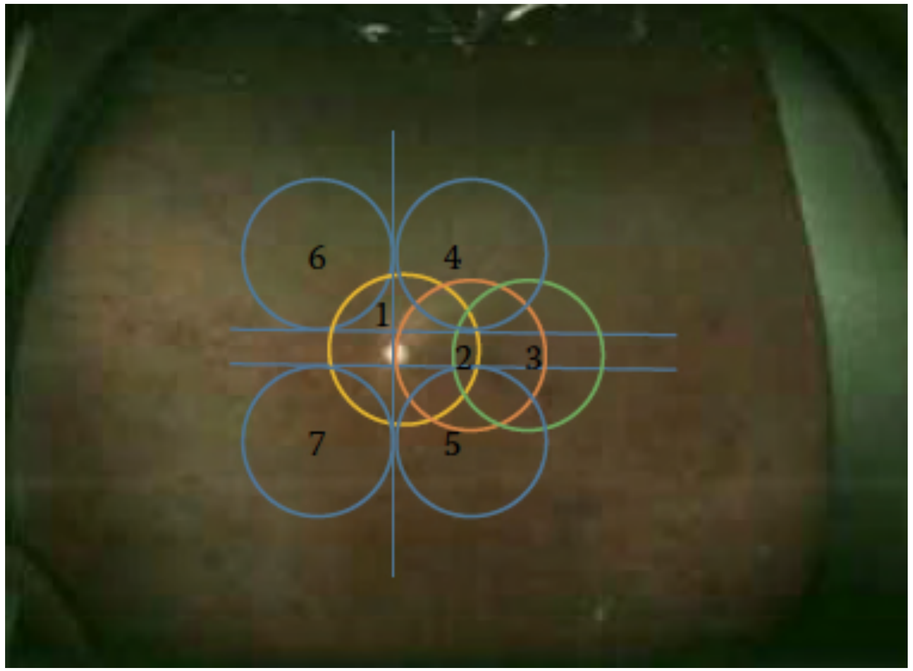
Wilson JM, Jungner G. Principles and practice of screening for disease. Geneva: World Health Organization; 1968

Screening for DR - When

- Within 5 years of diagnosis (ADA, AAO)
- Annual screening (AAO, ENSP)

Screening methods

- **Dilated fundal exam by ophthalmologist**
  - Gold standard
  - Cons: impossible to cover whole diabetic population
- **7-field stereoscopic photos**
  - Gold standard (especially in research)
  - Compared to ophthalmologist's exam, sensitivity of 20-53% and specificity of 90-100%
  - Cons: time-consuming, high rate of ungradable photos



Screening methods

- **Digital fundus photography**[1-3]
  - Single field (usually 45-50 degrees): sensitivity of 74% to 86% and specificity of 92% to 95% compared with gold standard; and this increases to almost 100% for sight-threatening diseases
  - Two/four-field photos can increase sensitivity and specificity further
  - Ultrawide field fundus imaging (100-200 degrees)
  - Artificial intelligence automated screening: sensitivity 80% to 100% and specificity 77.3% to 99.1% [4]

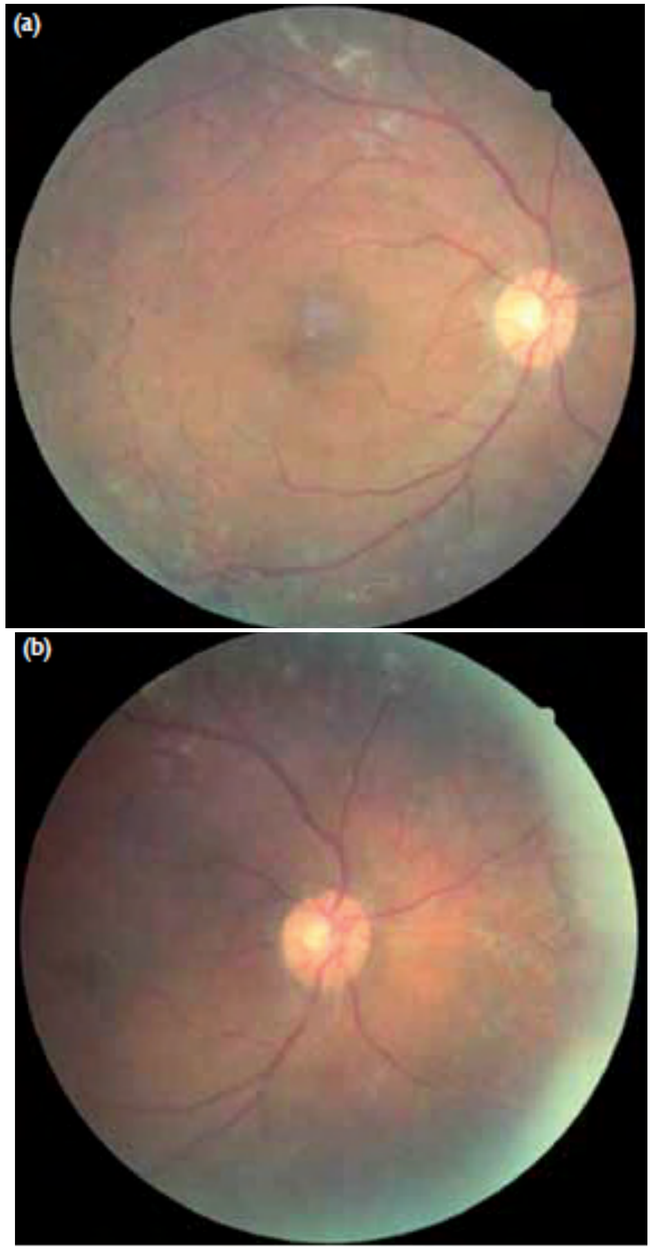
1. *Hutchinson A, McIntosh A, Peters J, O'Keeffe C, Khunti K, Baker R, et al. Effectiveness of screening and monitoring tests for diabetic retinopathy - a systematic review. Diabetic Medicine. 2000;17:495-506.*
2. *Williams GA, Scott IU, Haller JA, Maguire AM, Marcus D, McDonald HR. Single-field fundus photography for diabetic retinopathy screening: a report by the American Academy of Ophthalmology. Ophthalmology. 2004 May;111(5):1055-62. PubMed PMID: 15121388.*
3. *Gangwani R et al; Diabetic retinopathy screening: global and local perspective. HKMJ 22 (6): 486-495*
4. *Grzybowski et al; Artificial intelligence for diabetic retinopathy screening: a review; Eye (Lond) 2019 Sep 5. Epub ahead of print*

Risk assessment and management programme (RAMP)

- Started in 2010
- For all DM patients FU in GOPC
  - Over 80% patients in HK FU in public sector, and over 50% in primary care
- Holistic-screening programme for various diabetic complications (including renal diseases, examining feet and eyes), monitoring of associated CVS risks (e.g. BP), and educating patients about lifestyle modification

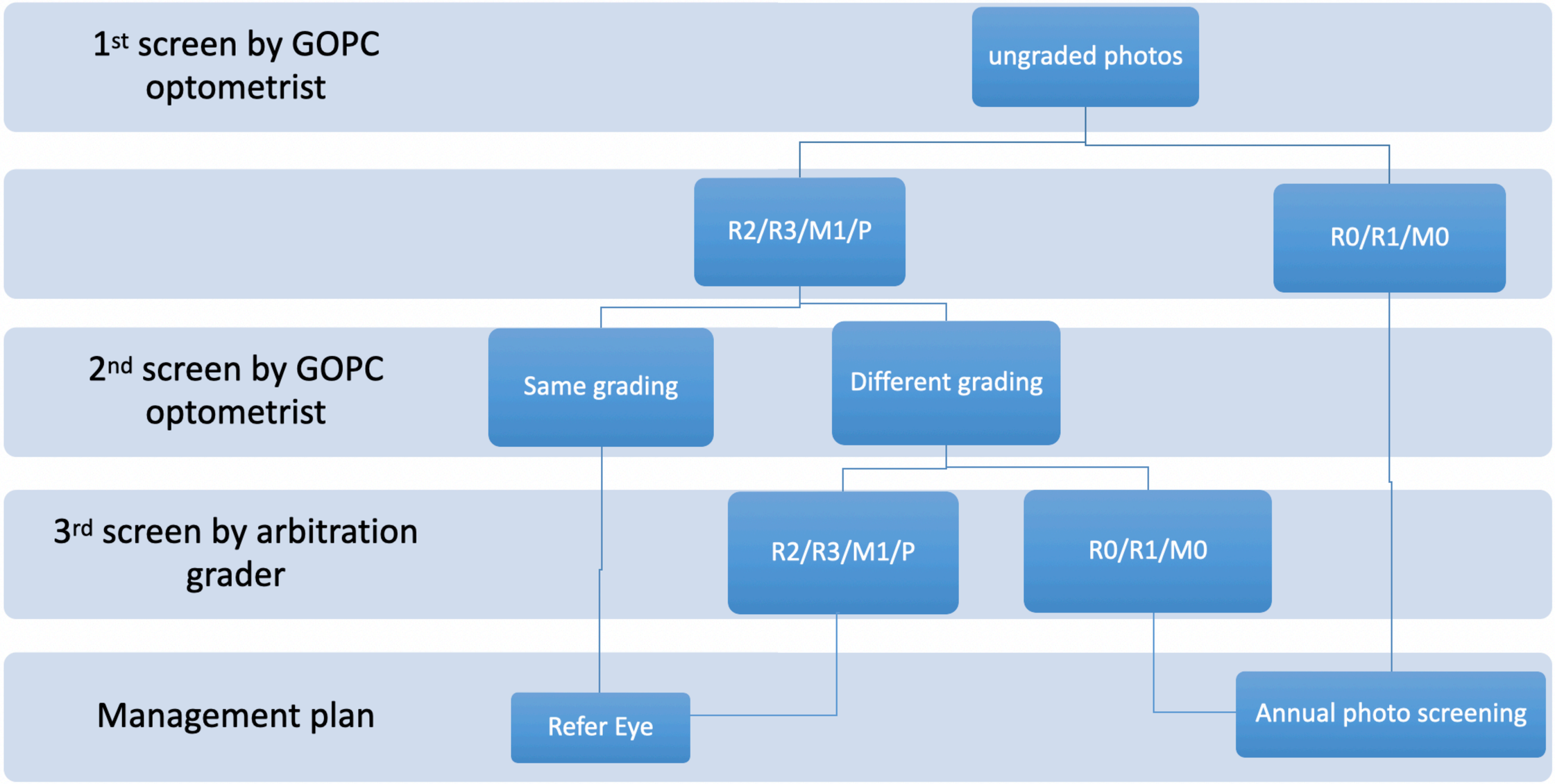
DR screening

- Visual acuity (VA) using ETDRS chart
  - Habitual and pin-hole
- Digital fundus photo
  - Pupils dilated unless otherwise contraindicated
  - Non-stereoscopic colour photo
  - Two 45-degree fundus photo, centered at macula and disc respectively

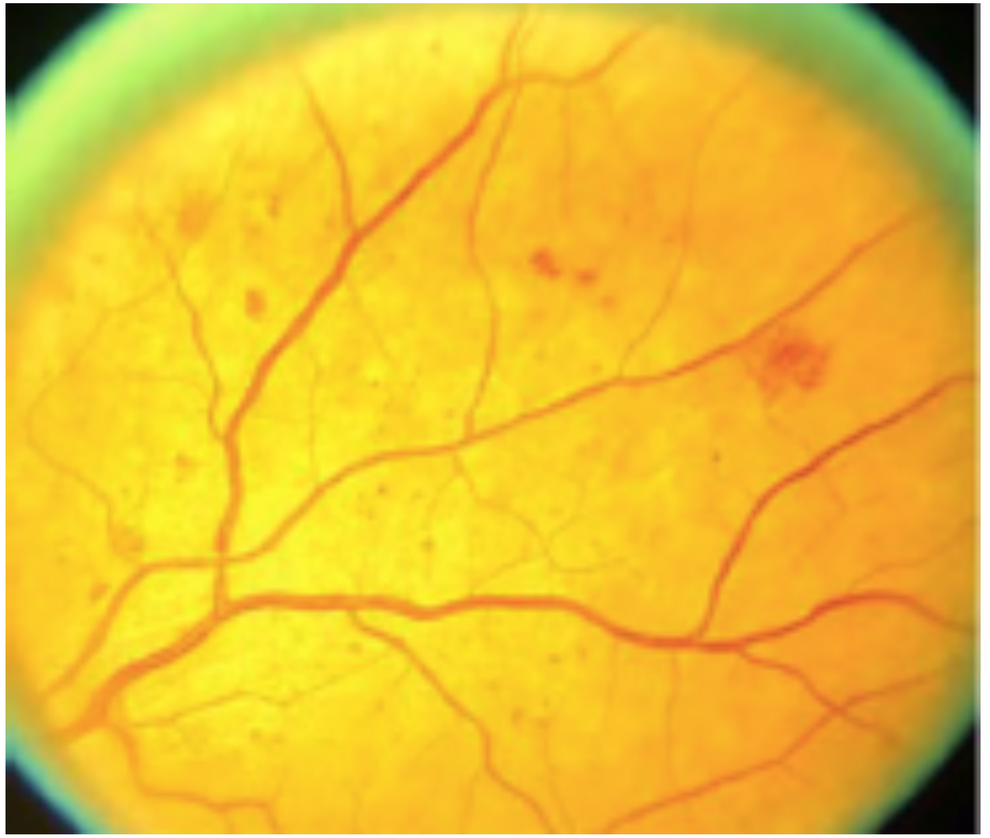


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Fundus photo screening at RAMP

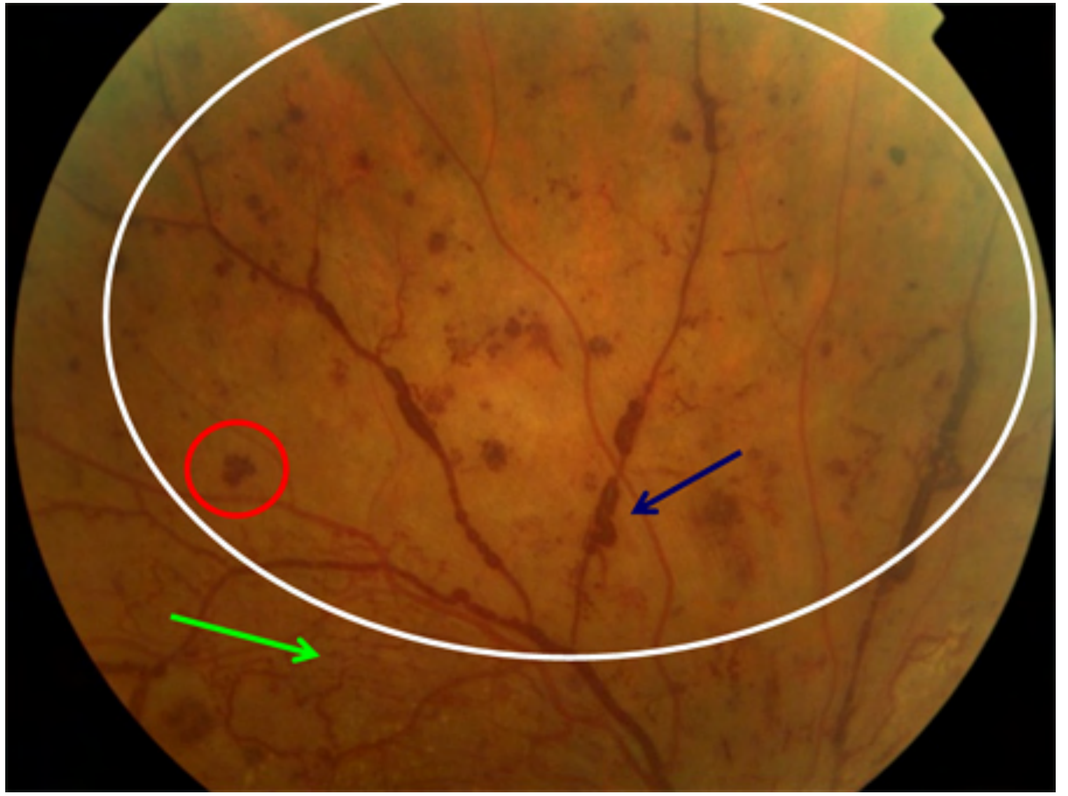


International Clinical DR/Mac Severity Scale	ETDRS Grading	NSC Retinopathy Grading Standard	Main clinical features
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By dilated ophthalmoscopy	By 7-field stereoscopic photos	By Digital fundus photo	
No retinopathy	Level 10	R0	No abnormalities
Mild NPDR*	Level 20	R1	Microaneurysms
Moderate NPDR*	Levels 35, 43, 47	R2	In between mild and severe disease
Severe NPDR*	Level 53	R2.5	Extensive haemorrhage, venous beading/looping, IRMA
PDR*	Levels 61, 65, 71, 75, 81, 85:	R3	Neovascularisation vitreous/pre-retinal haemorrhage
Macular oedema present	CSME**	M1	Posterior pole retinal thickening or hard exudate
		P	Laser photocoagulation



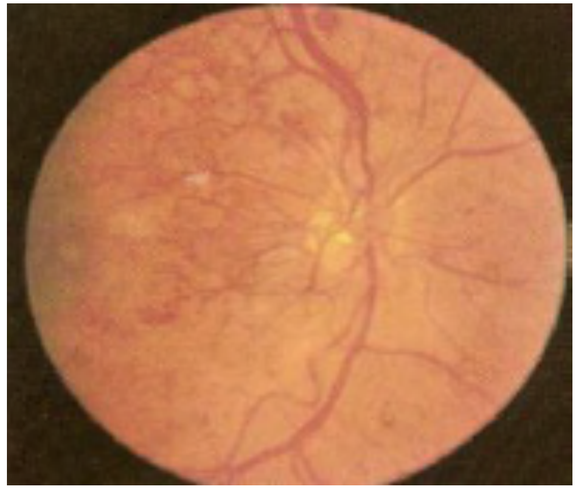
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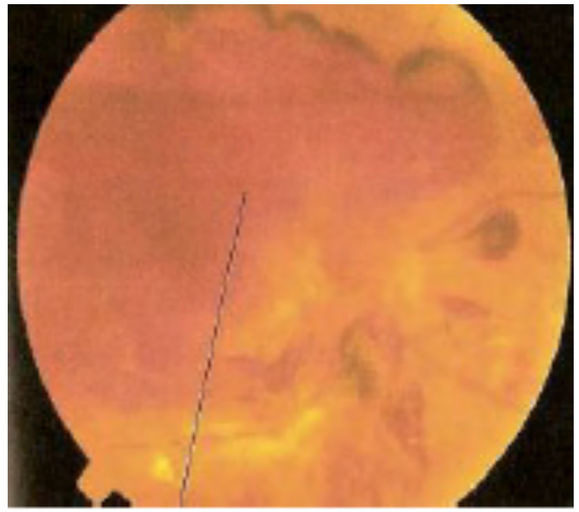
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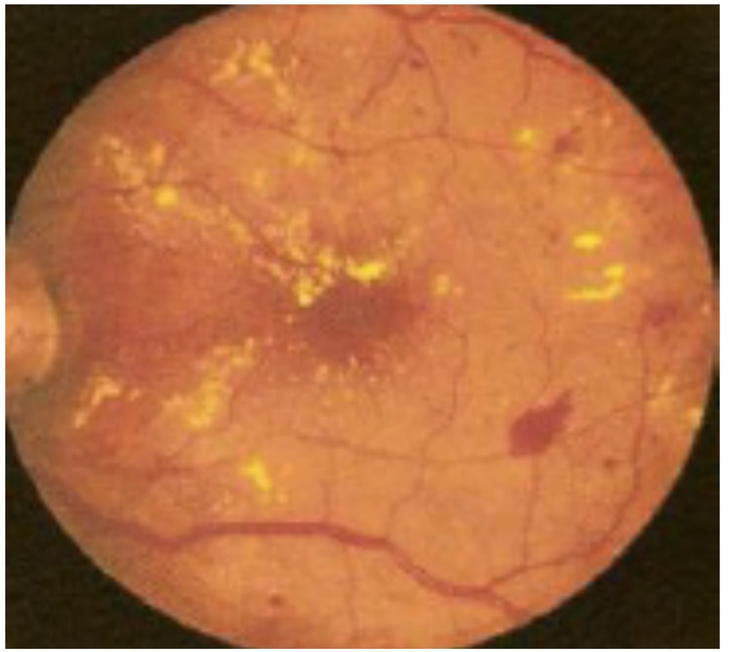
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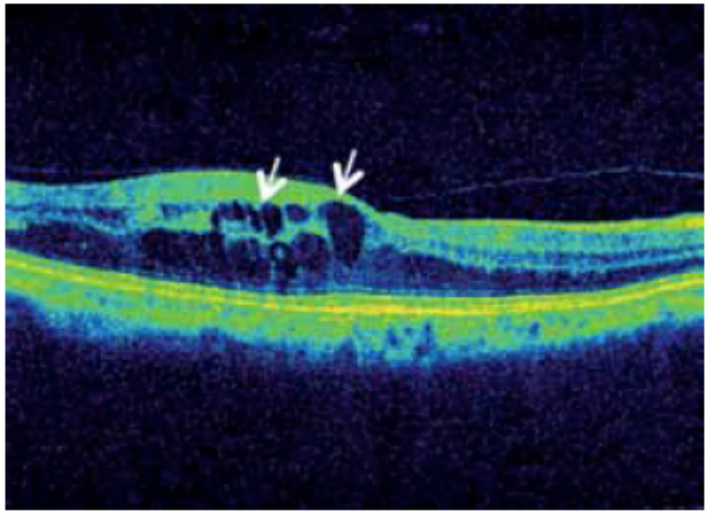
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1. Hard exudate within one disc diameter of the centre of the fovea or
2. Microaneurysm or dot haemorrhage within one disc diameter of the centre of fovea in the presence of visual acuity of ≤6/12 in the absence of any other obvious cause

1. *Operational manual for Risk Factor Assessment and Management Programme in Specialist Out-patient Clinic (RAMP-SOPC). Hong Kong: Hospital Authority, 2010*
2. *Kinshuck D. Examining and grading retinopathy, for professionals. Available from: http://www. diabeticretinopathy.org.uk/gradingretinopathy.htm. Accessed 20 Aug 2015.*

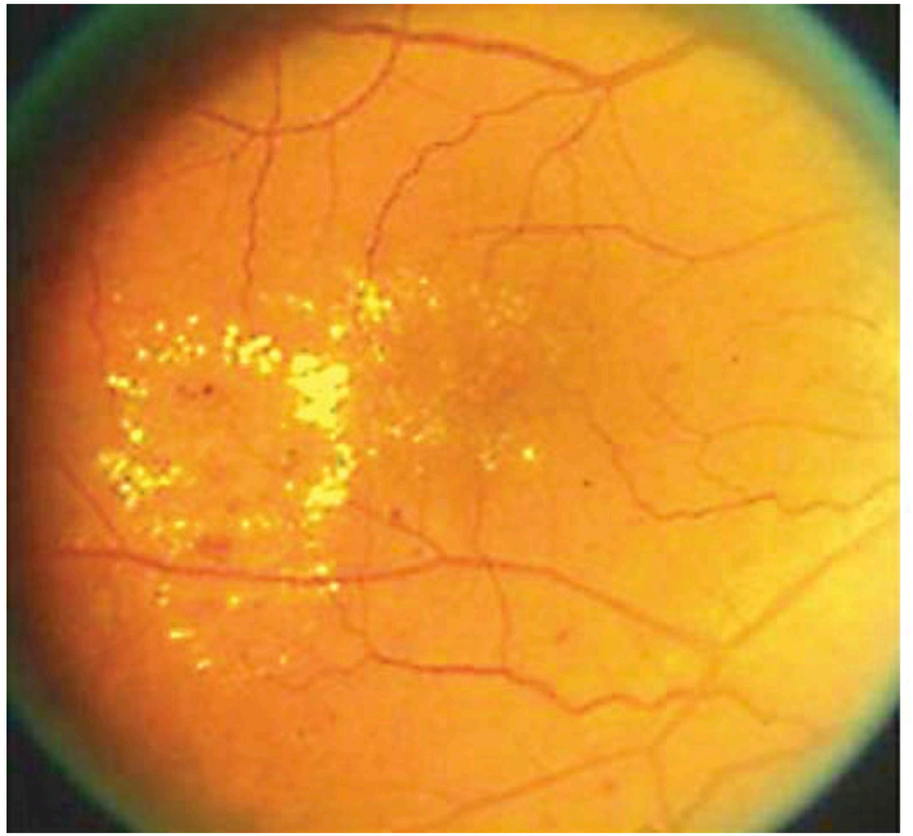
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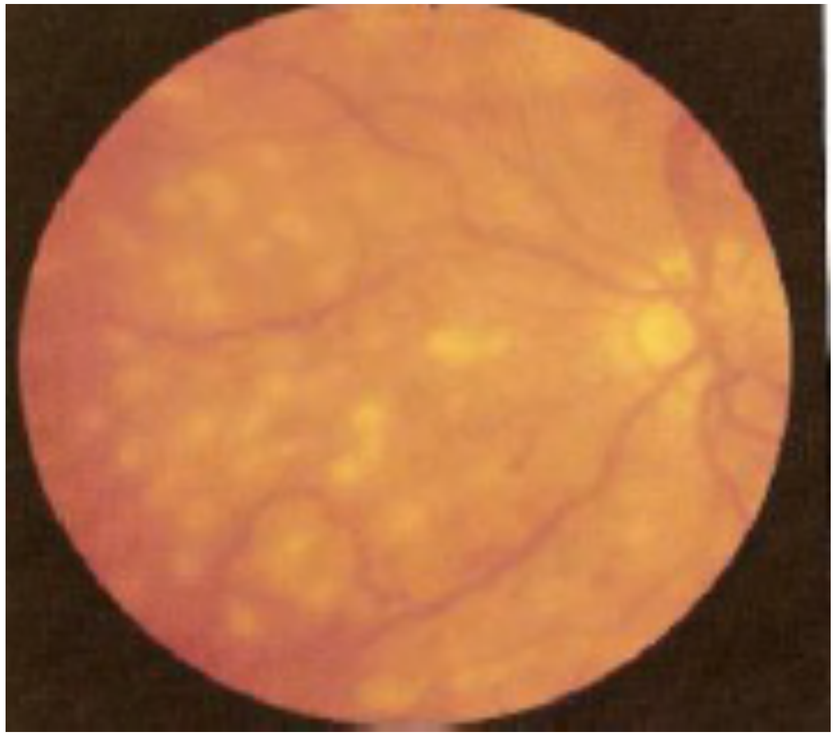
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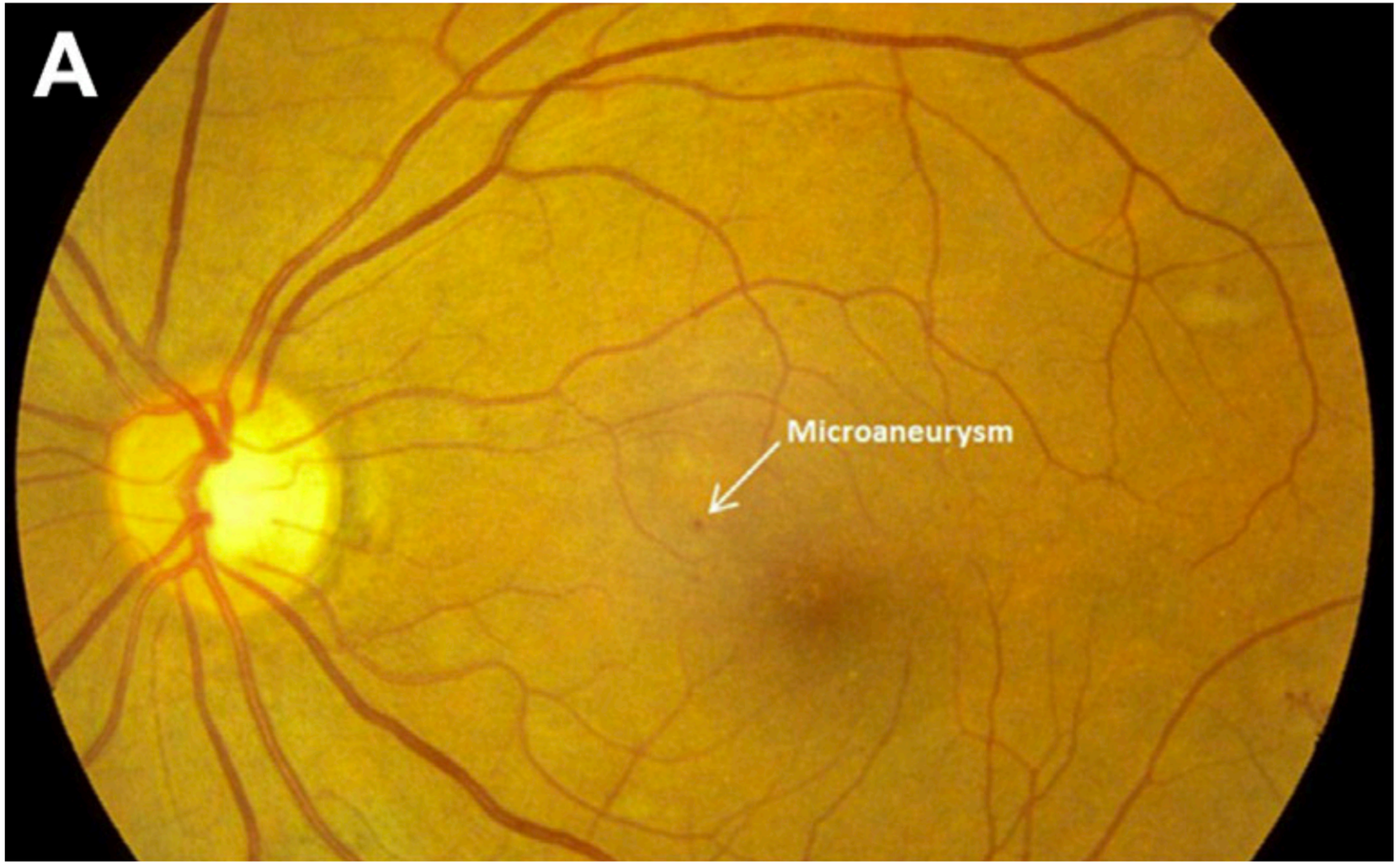


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2. *Schmidt-Erfurth U, Garcia-Arumi J, Bandello F, Berg K, Chakravarthy U, Gerendas BS, Jonas J, Larsen M, Tadayoni R, Loewenstein A. Guidelines for the Management of Diabetic Macular Edema by the European Society of Retina Specialists (EURETINA). Ophthalmologica. 2017;237(4):185-222. doi: 10.1159/000458539. Epub 2017 Apr 20. PMID: 28423385.*

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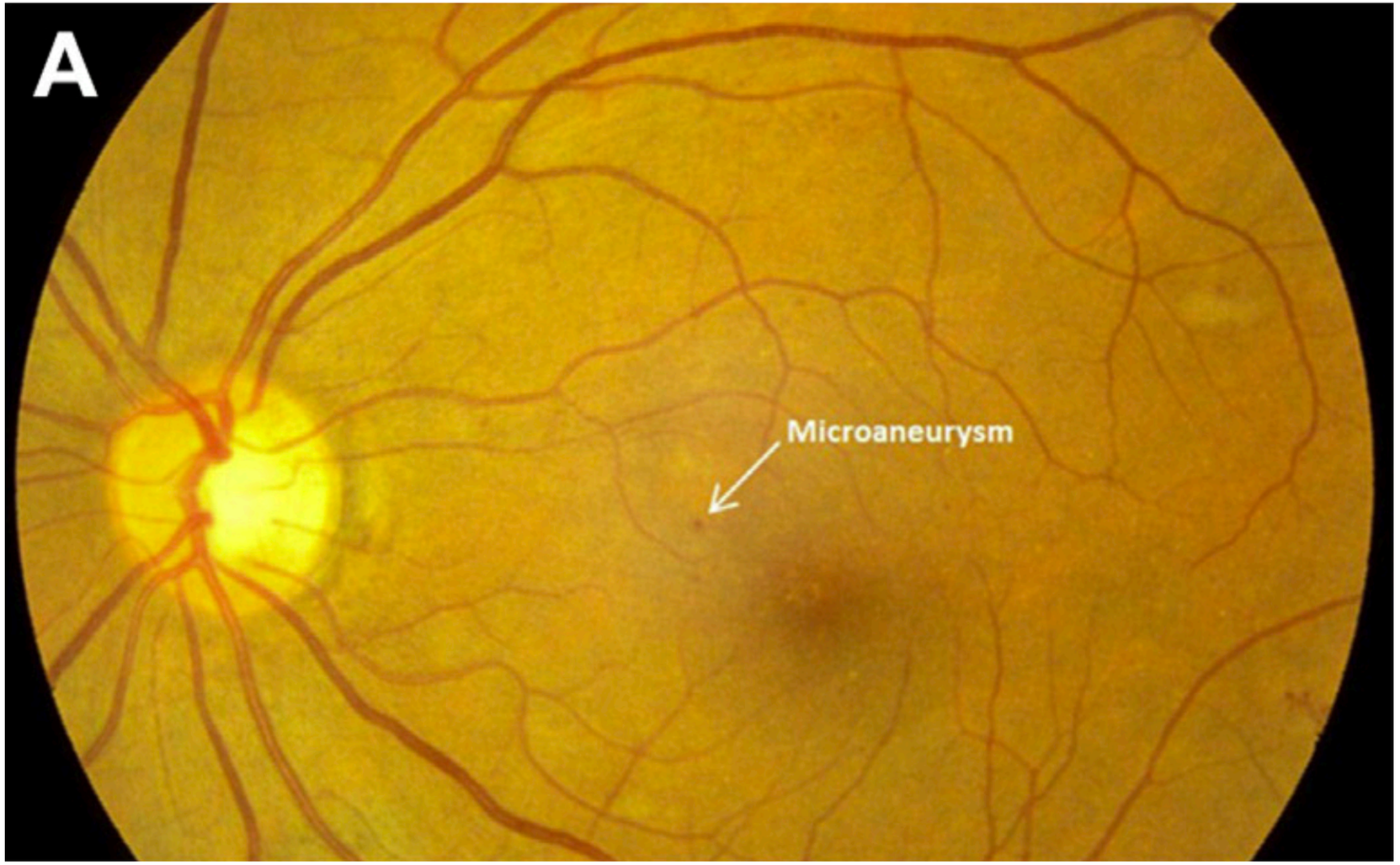


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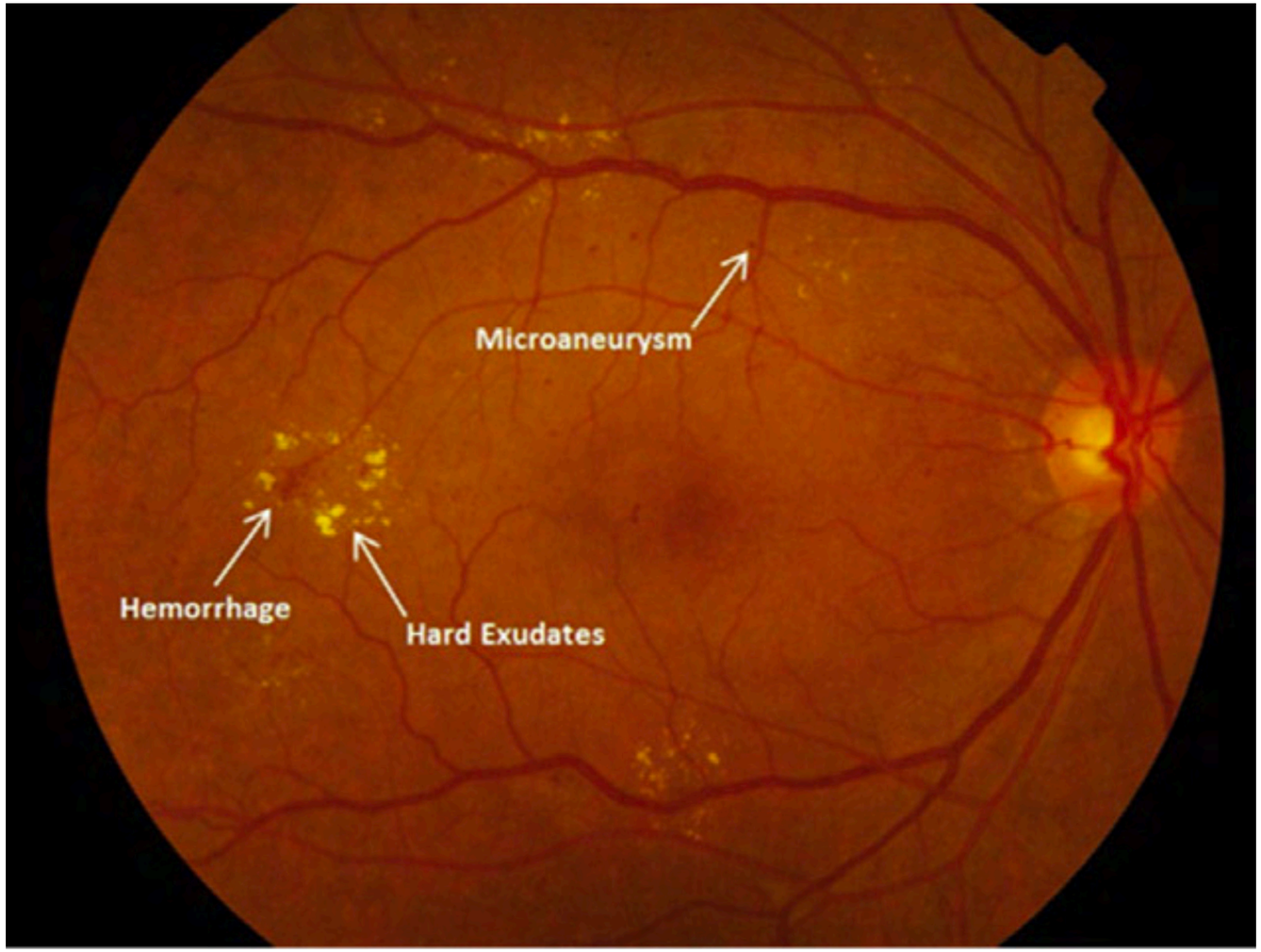


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Mild NPDMR (R1)

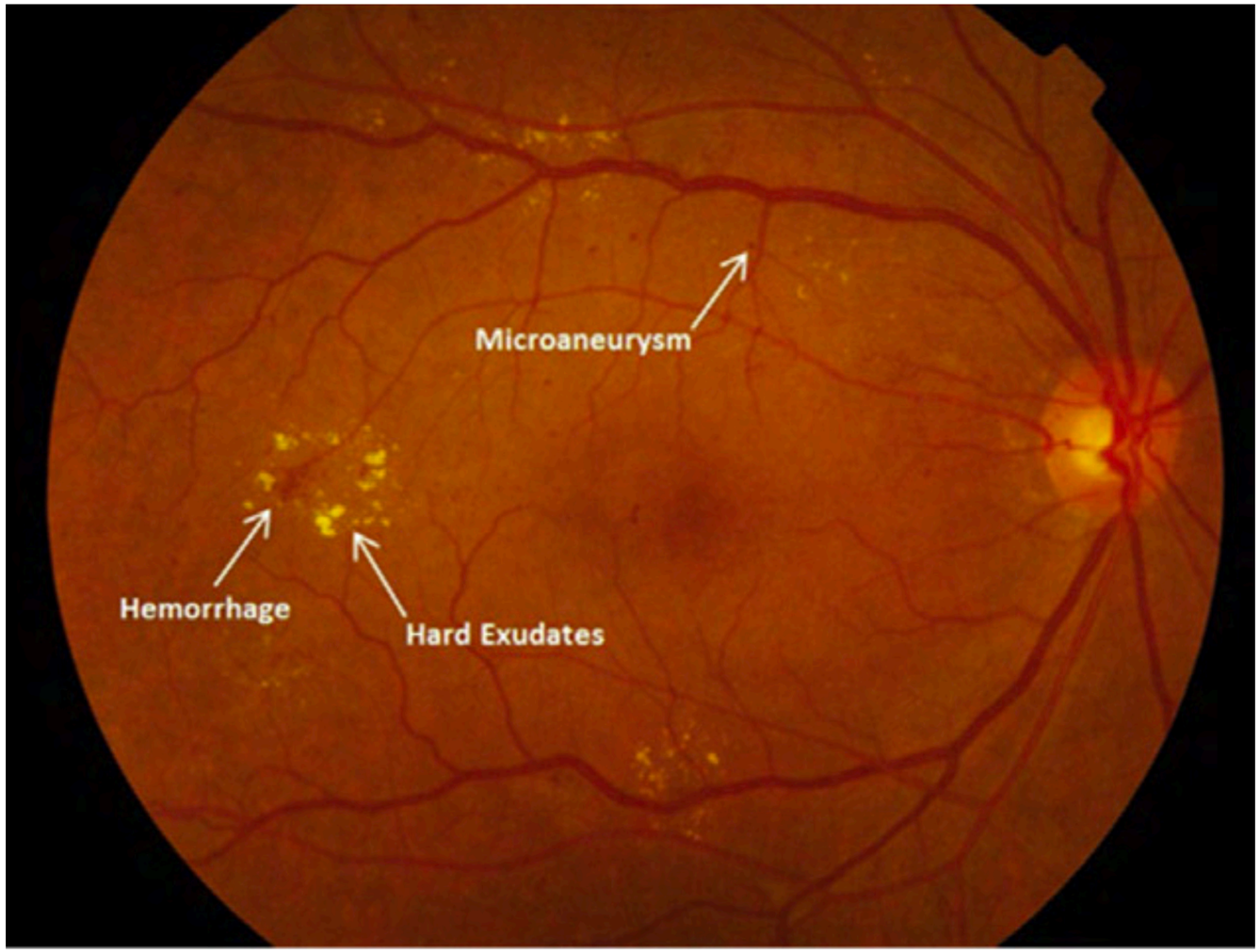


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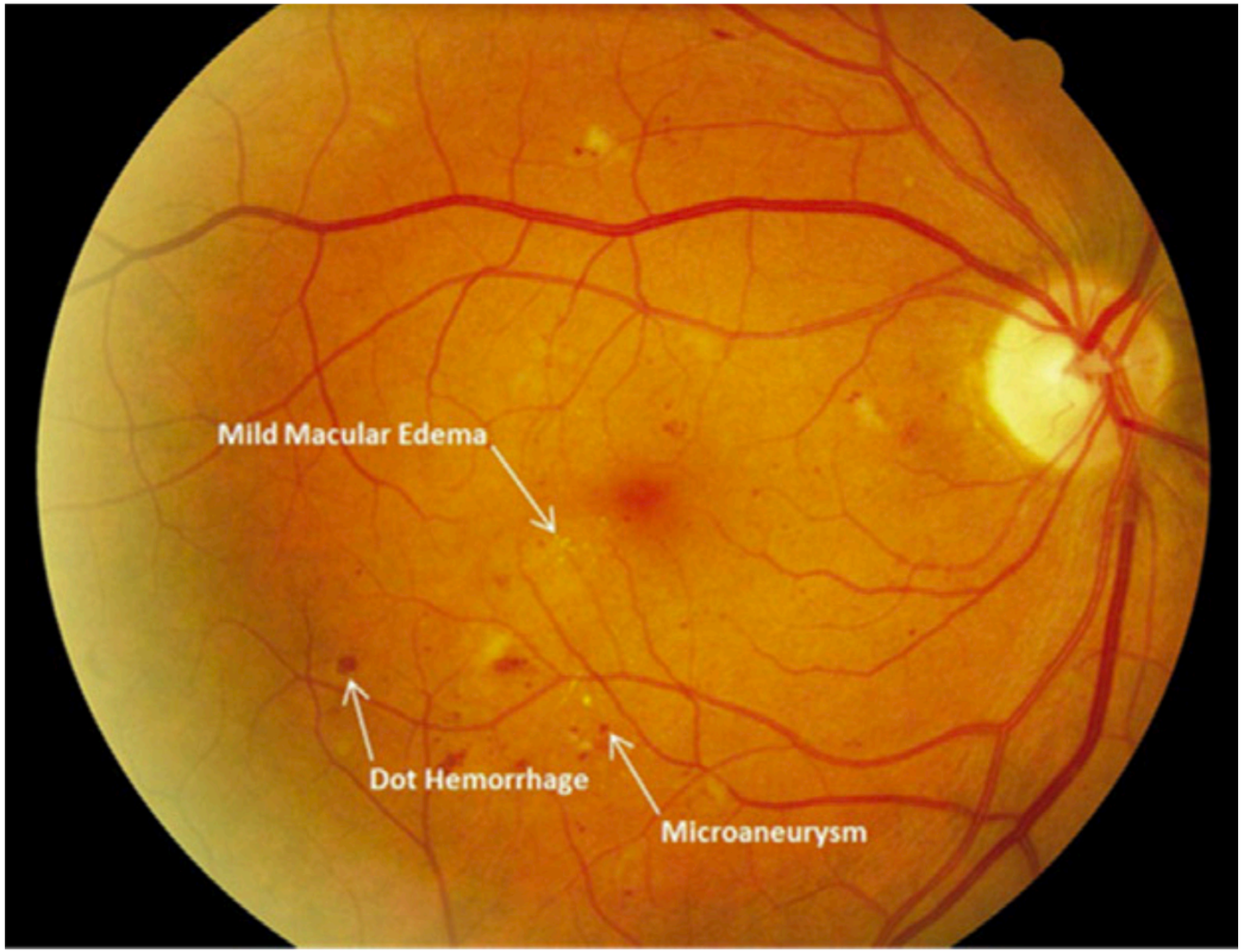


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Moderate NPDMR (R2)

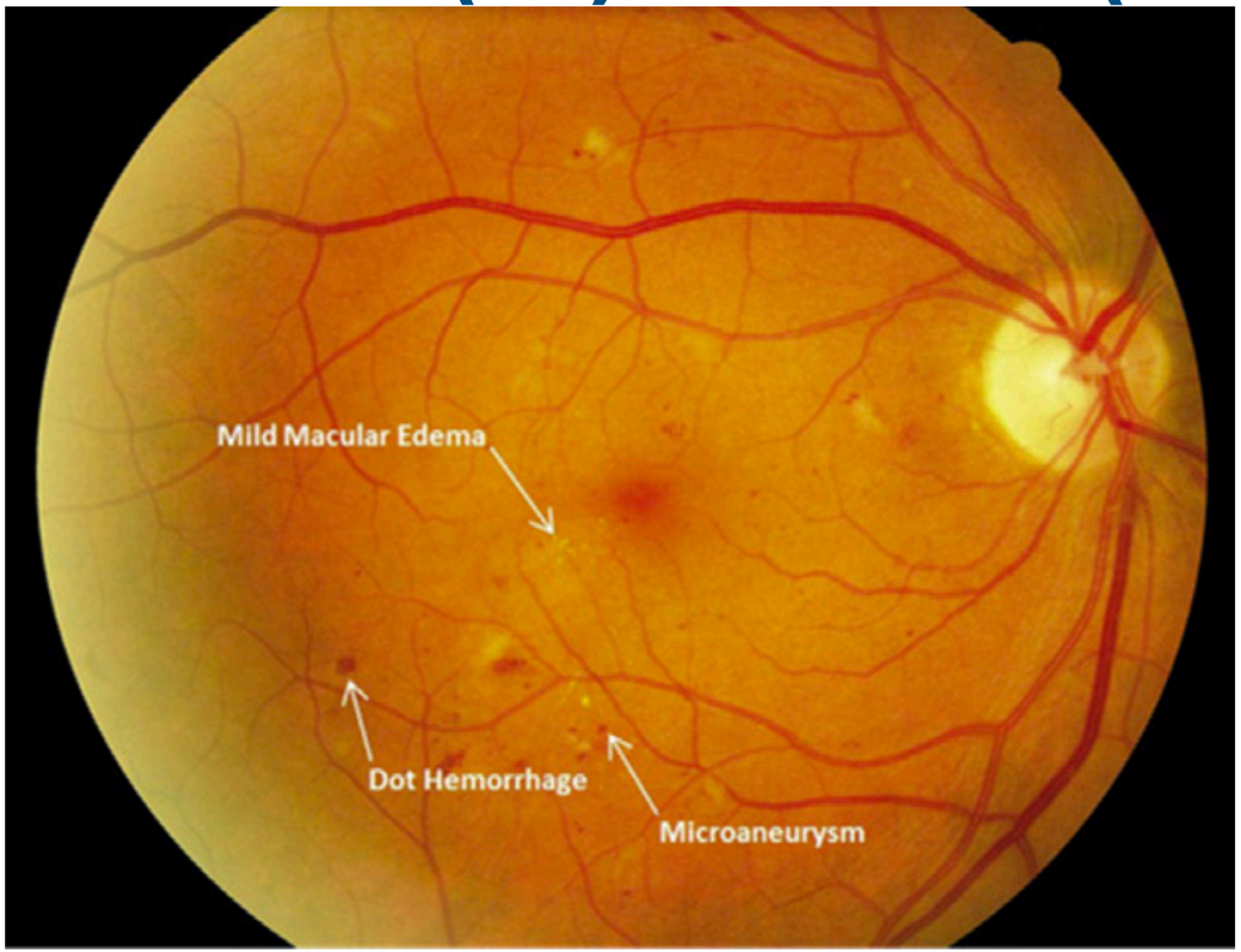


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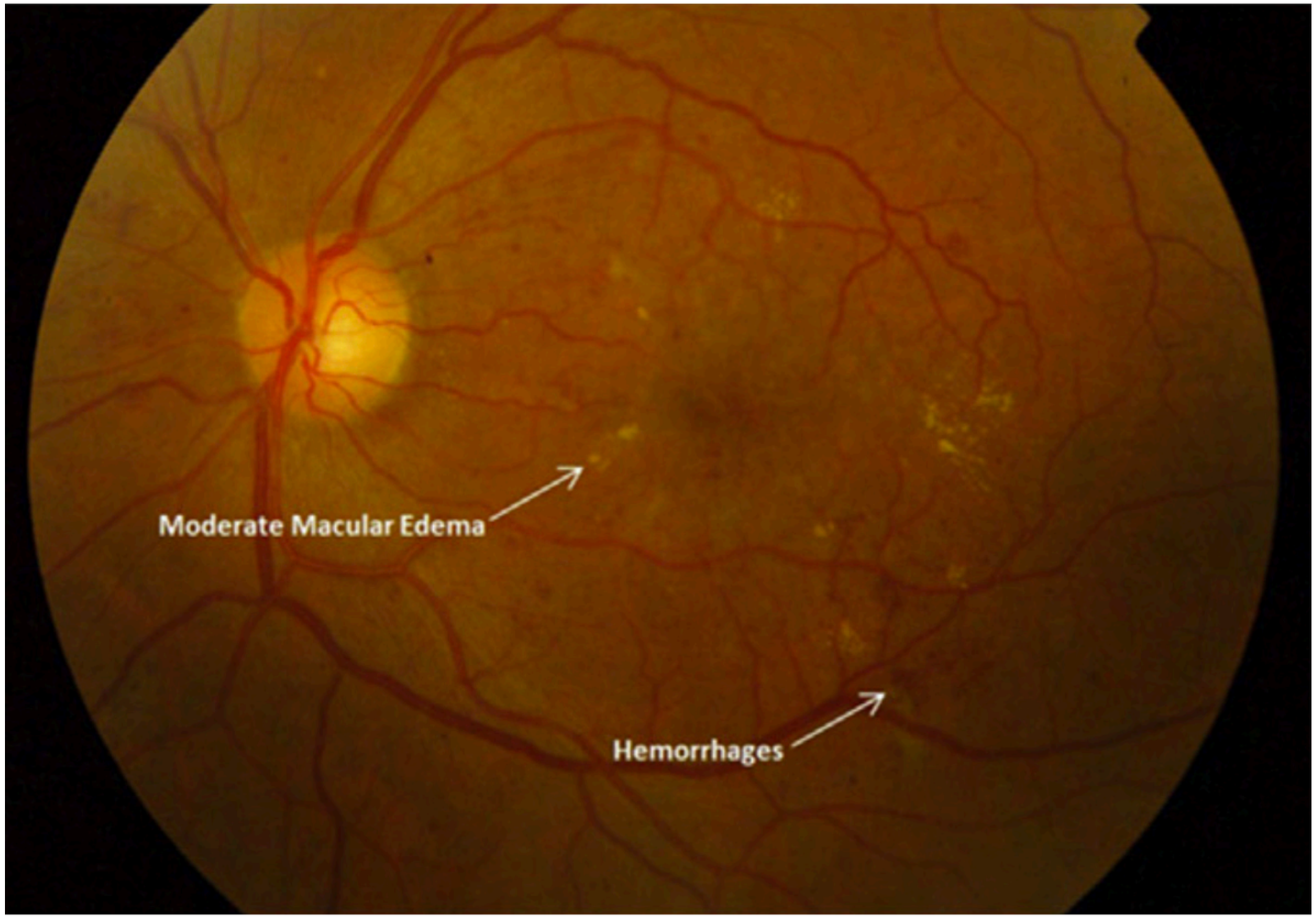


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Moderate NPDMR (R2)+ Mild ME (M1)

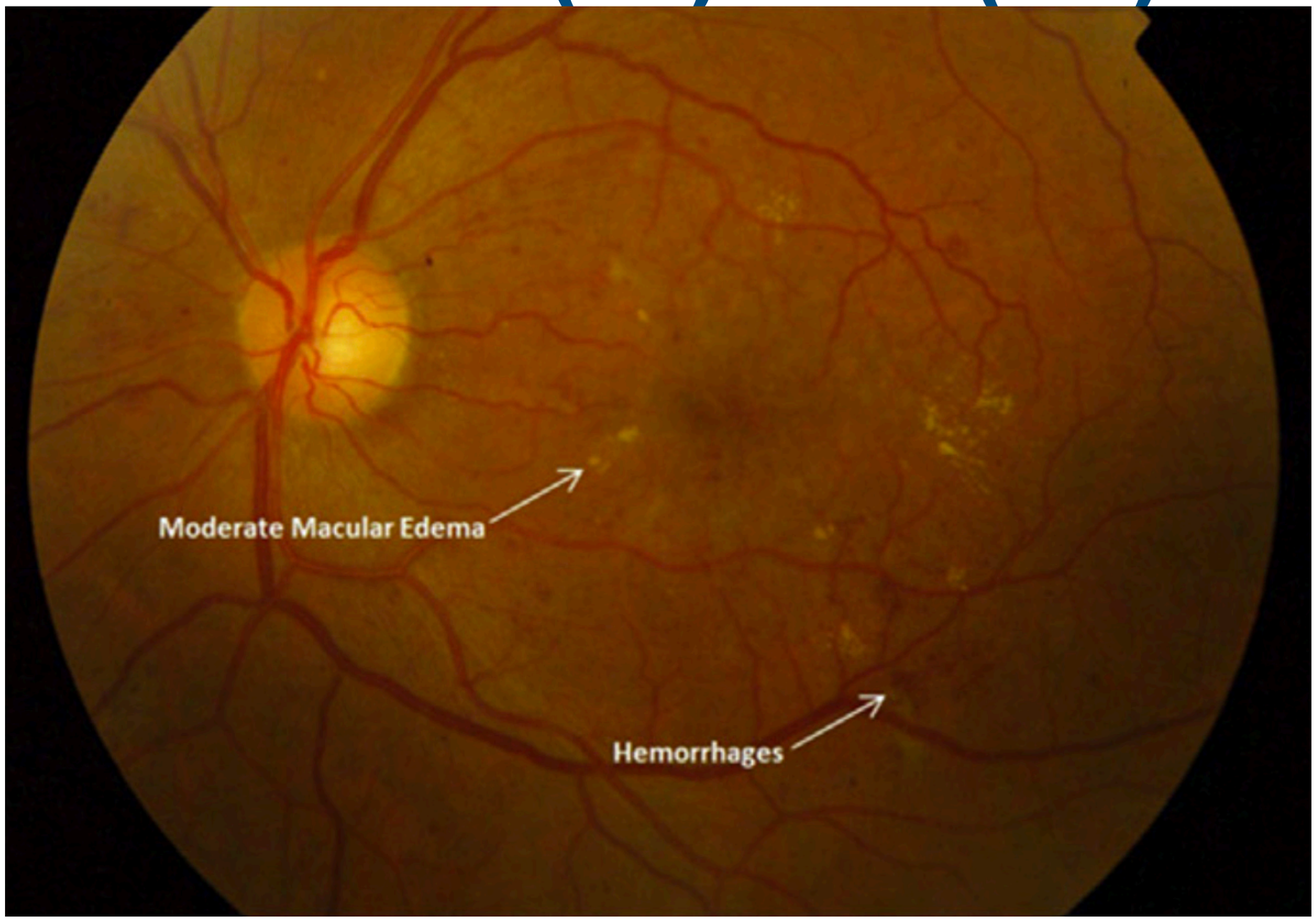


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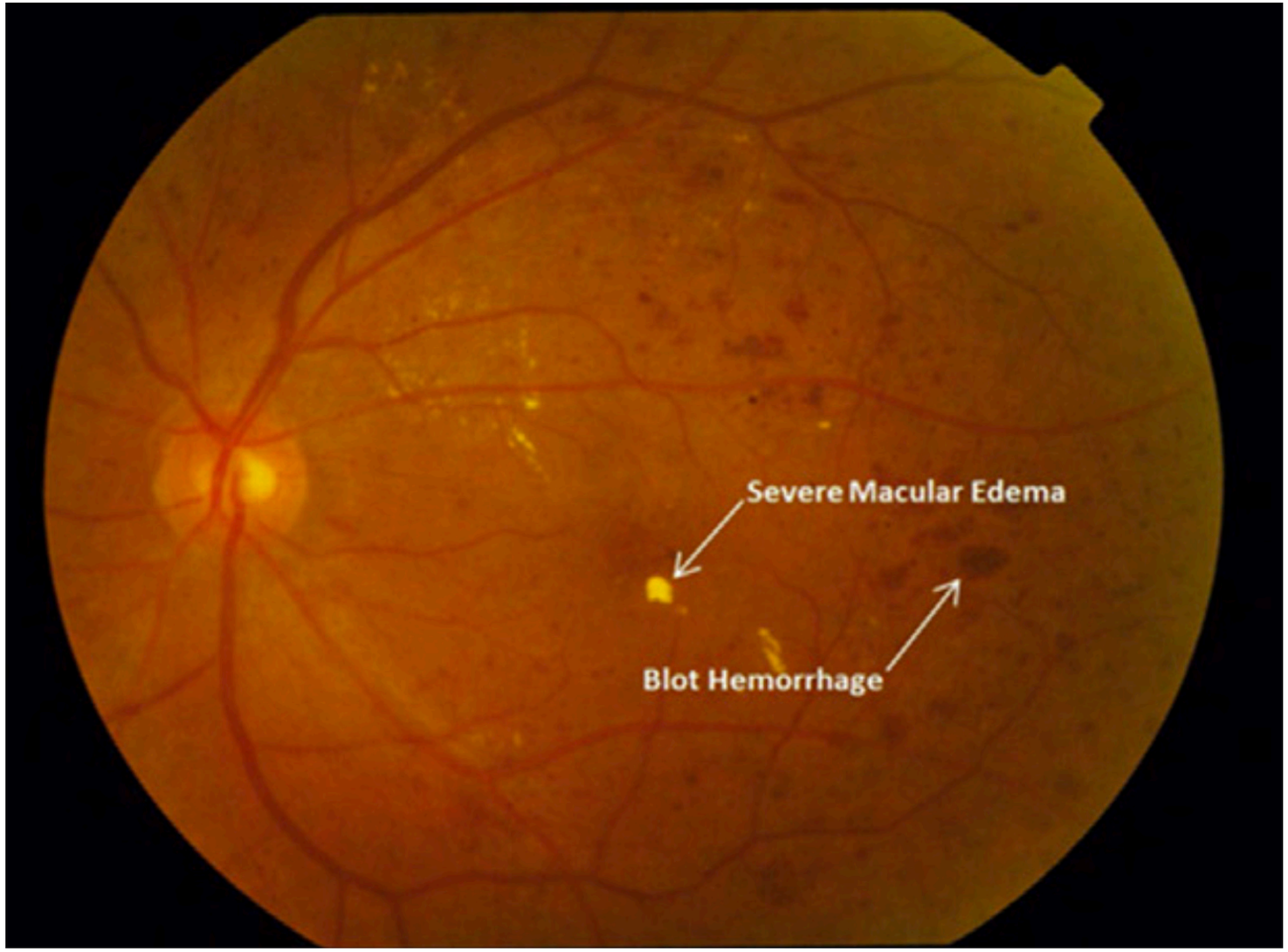


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Moderate NPDMR (R2)+ ME (M1)

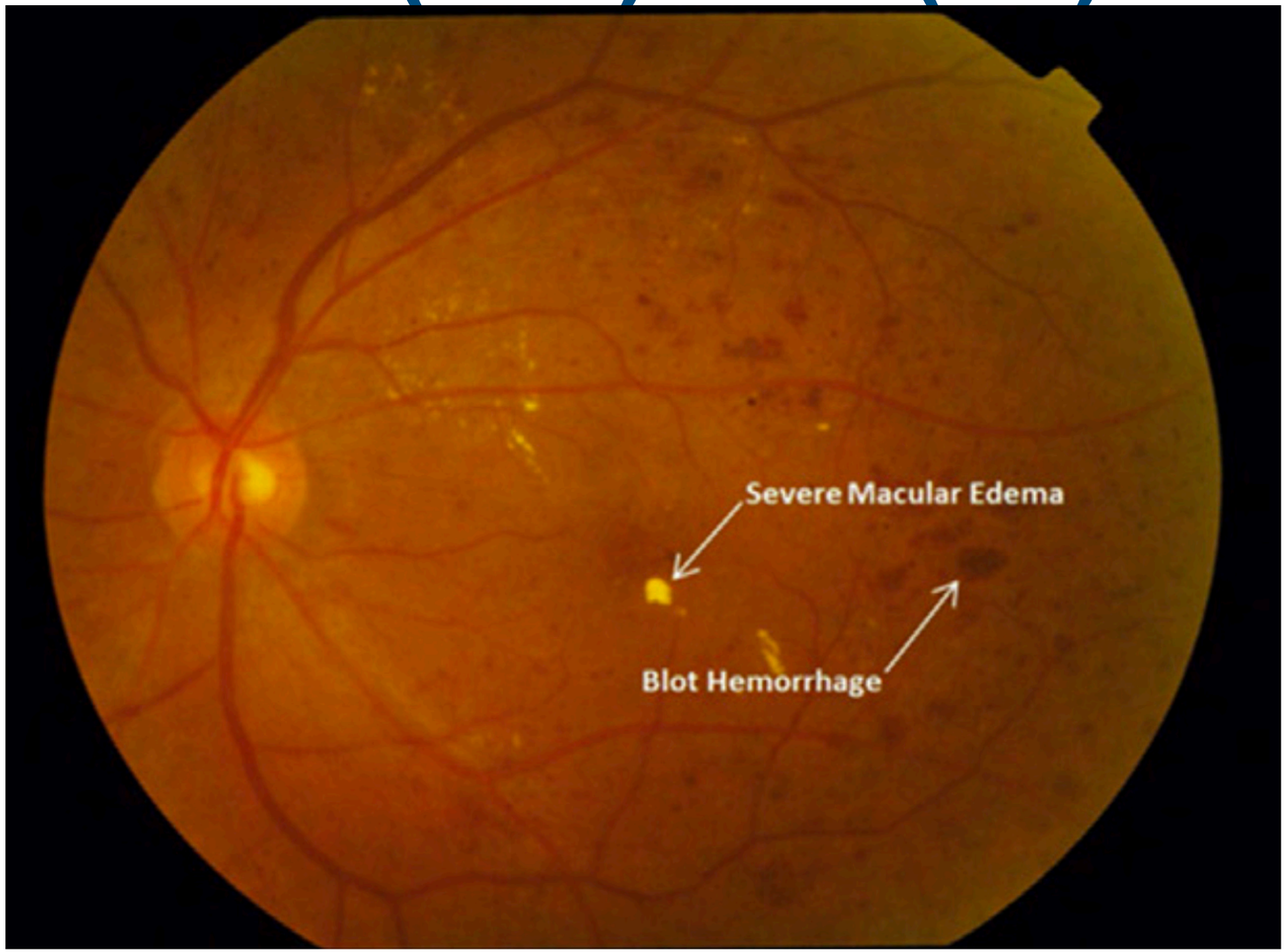


Wong TY, Sun J, Kawasaki R, Ruamviboonsuk P, Gupta N, Lansingh VC, Maia M, Mathenge W, Moreker S, Muqit MMK, Resnikoff S, Verdaguer J, Zhao P, Ferris F, Aiello LP, Taylor HR. Guidelines on Diabetic Eye Care: The International Council of Ophthalmology Recommendations for Screening, Follow-up, Referral, and Treatment Based on Resource Settings. Ophthalmology. 2018 Oct;125(10):1608-1622. doi: 10.1016/j.ophtha.2018.04.007. Epub 2018 May 24. PMID: 29776671.

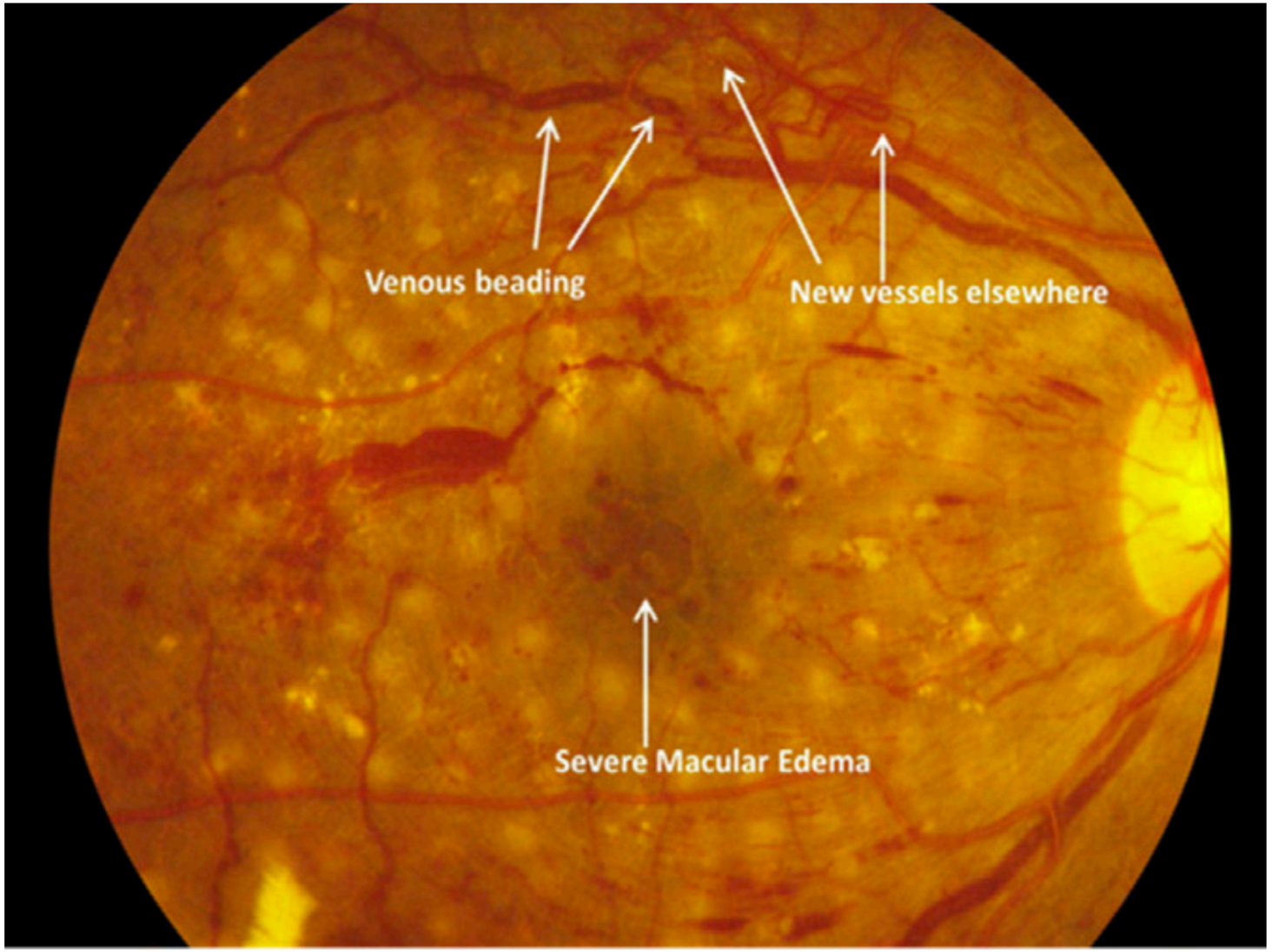


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Severe NPDMR (R2.5)+ ME (M1)

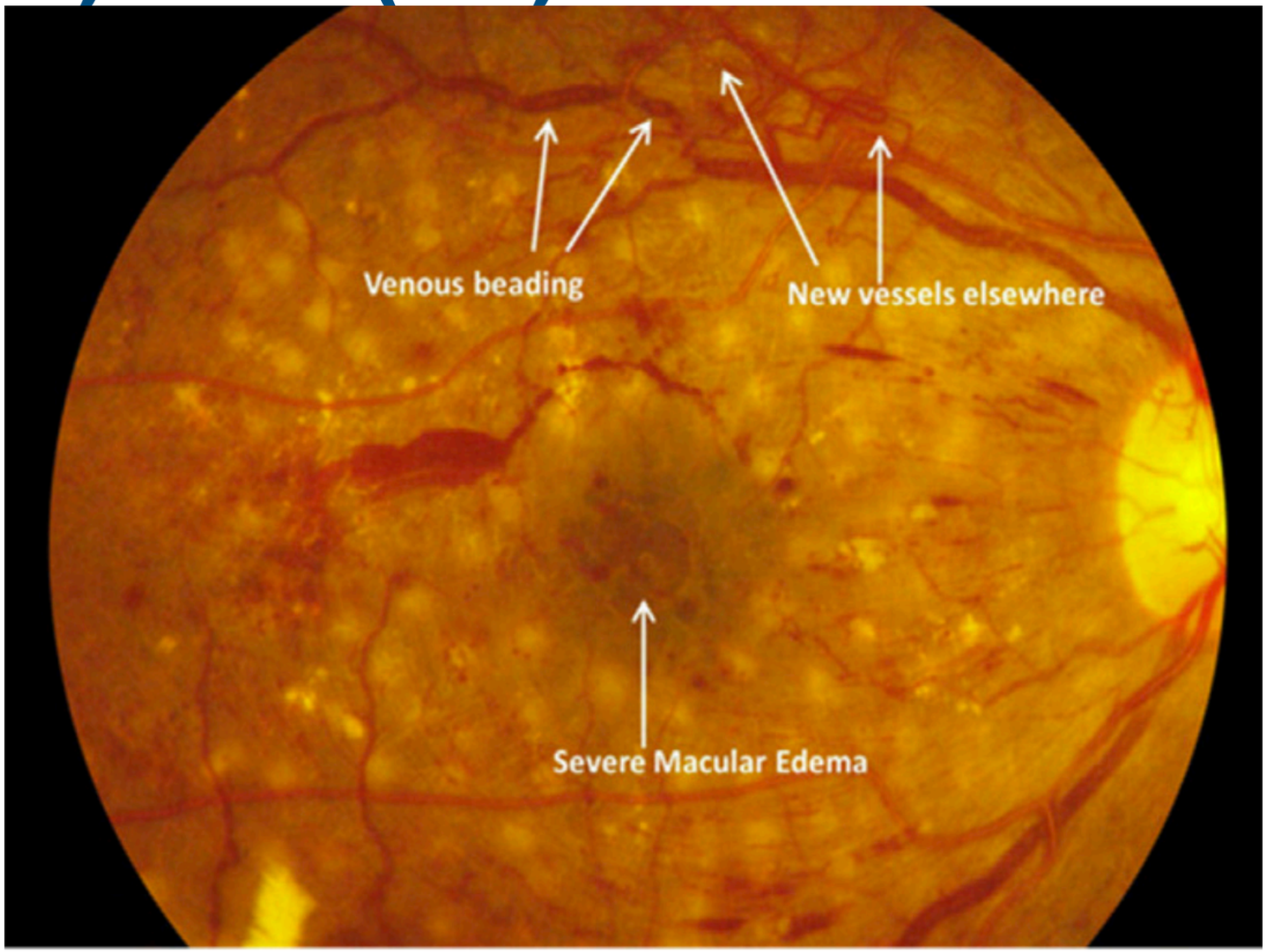


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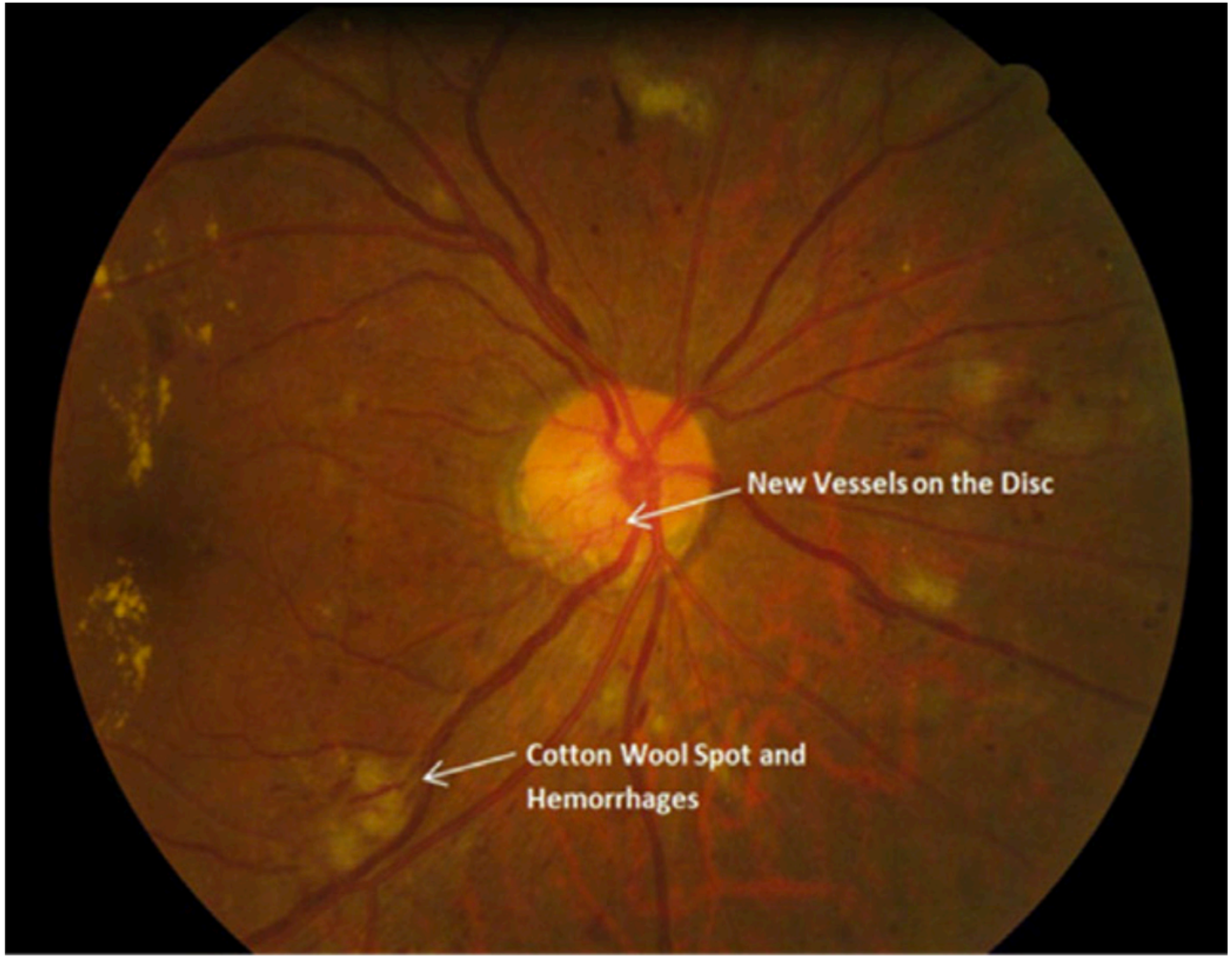


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PDMR (R3)+ ME (M1)

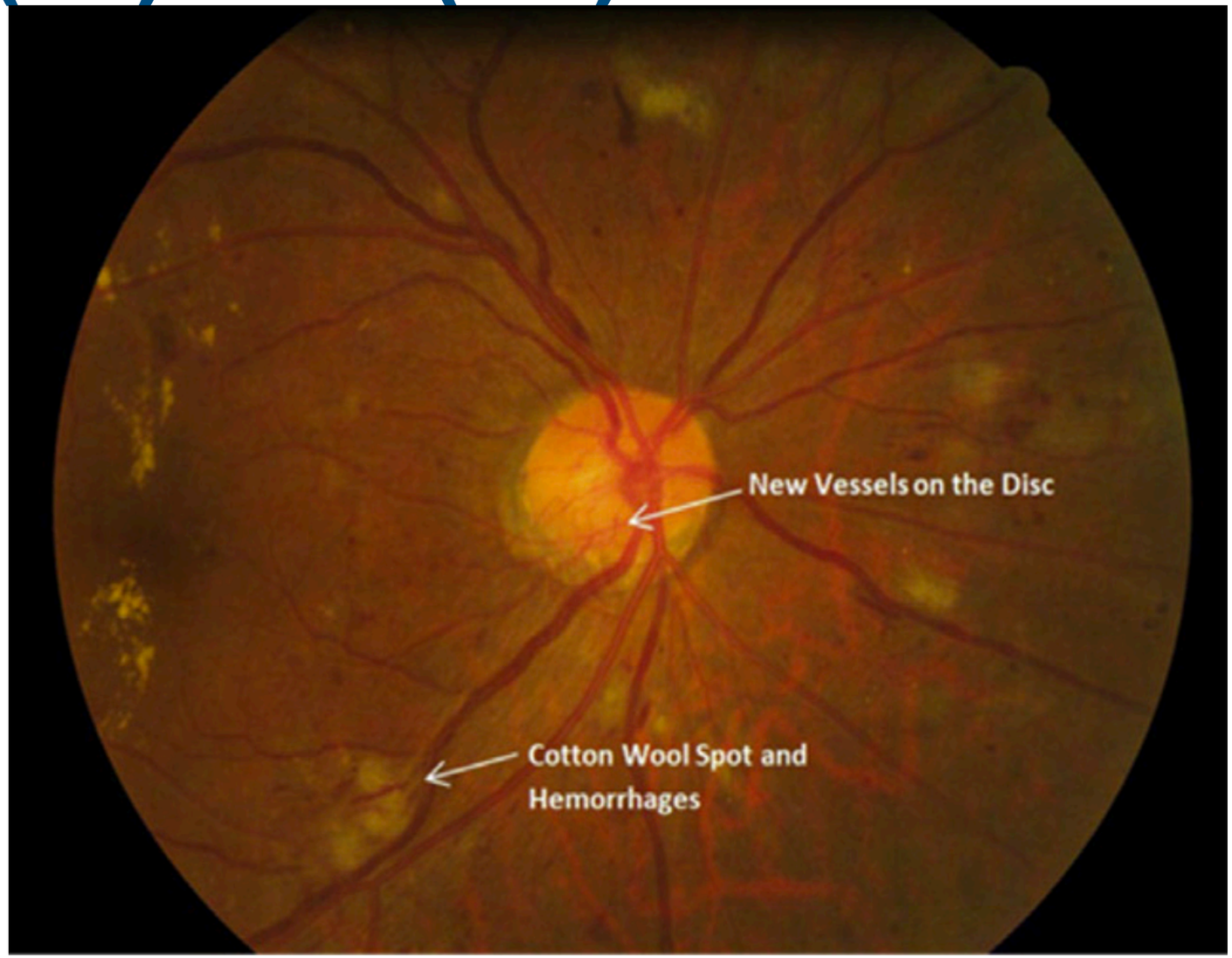


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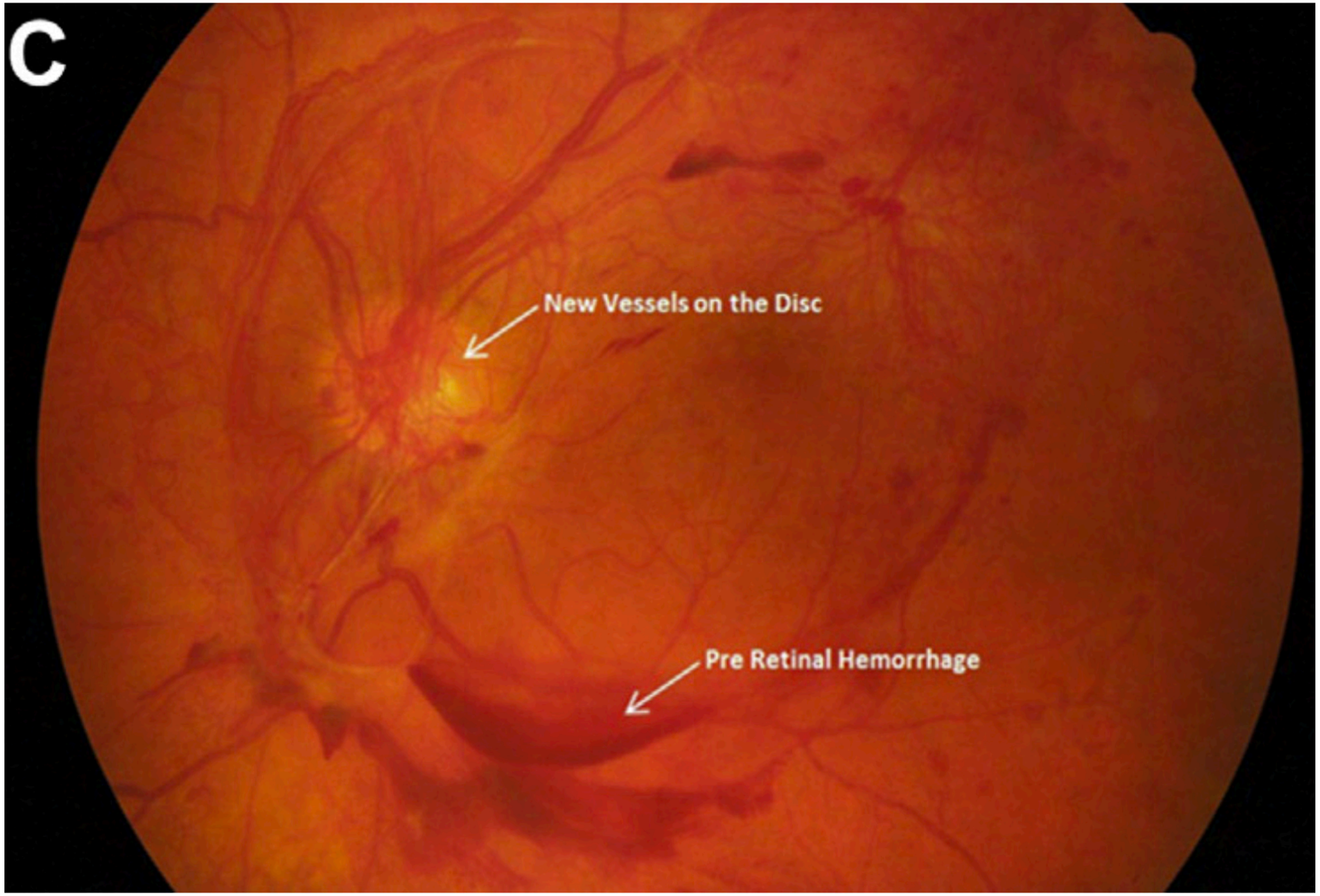


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PDMR (R3)+ ME (M1)

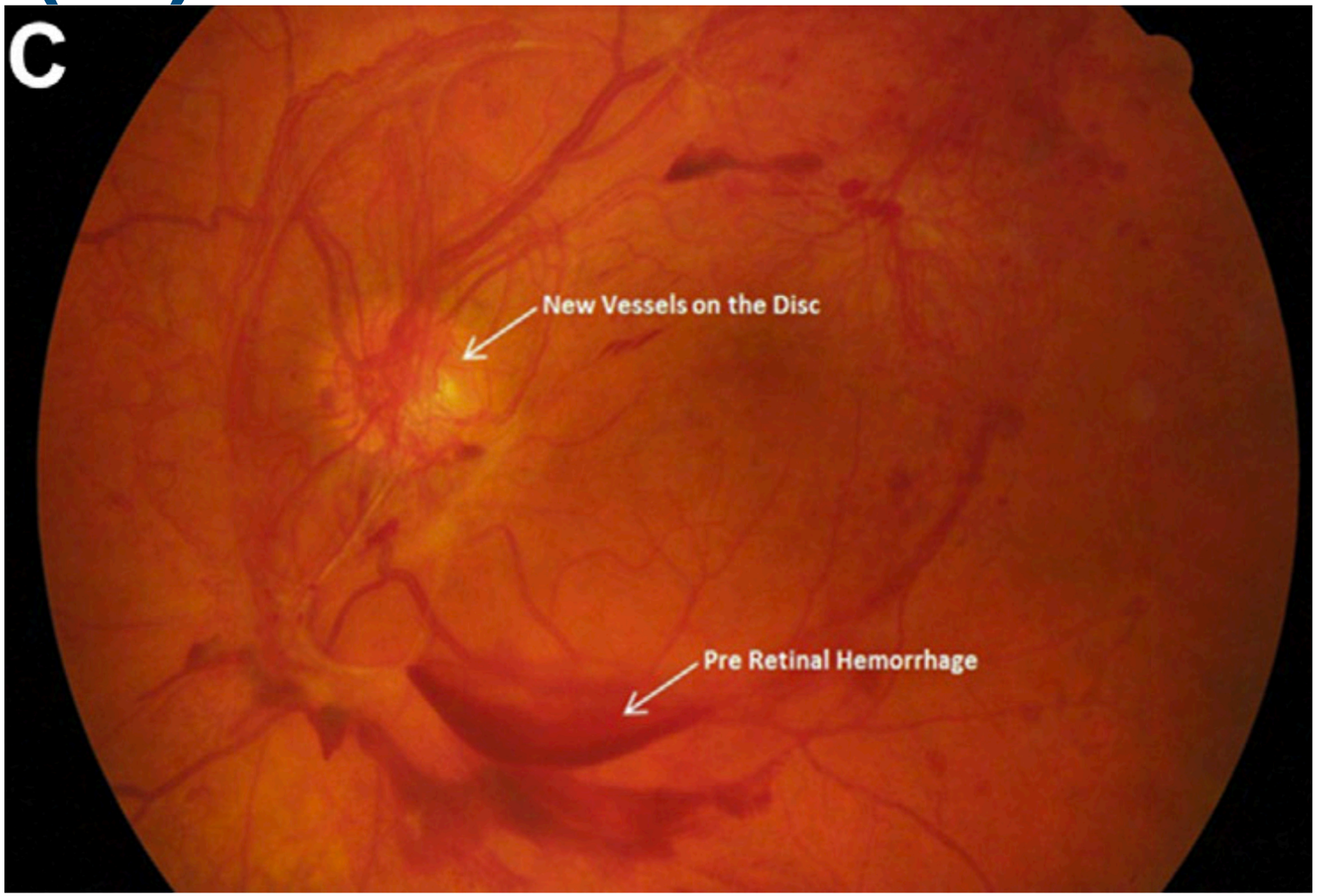


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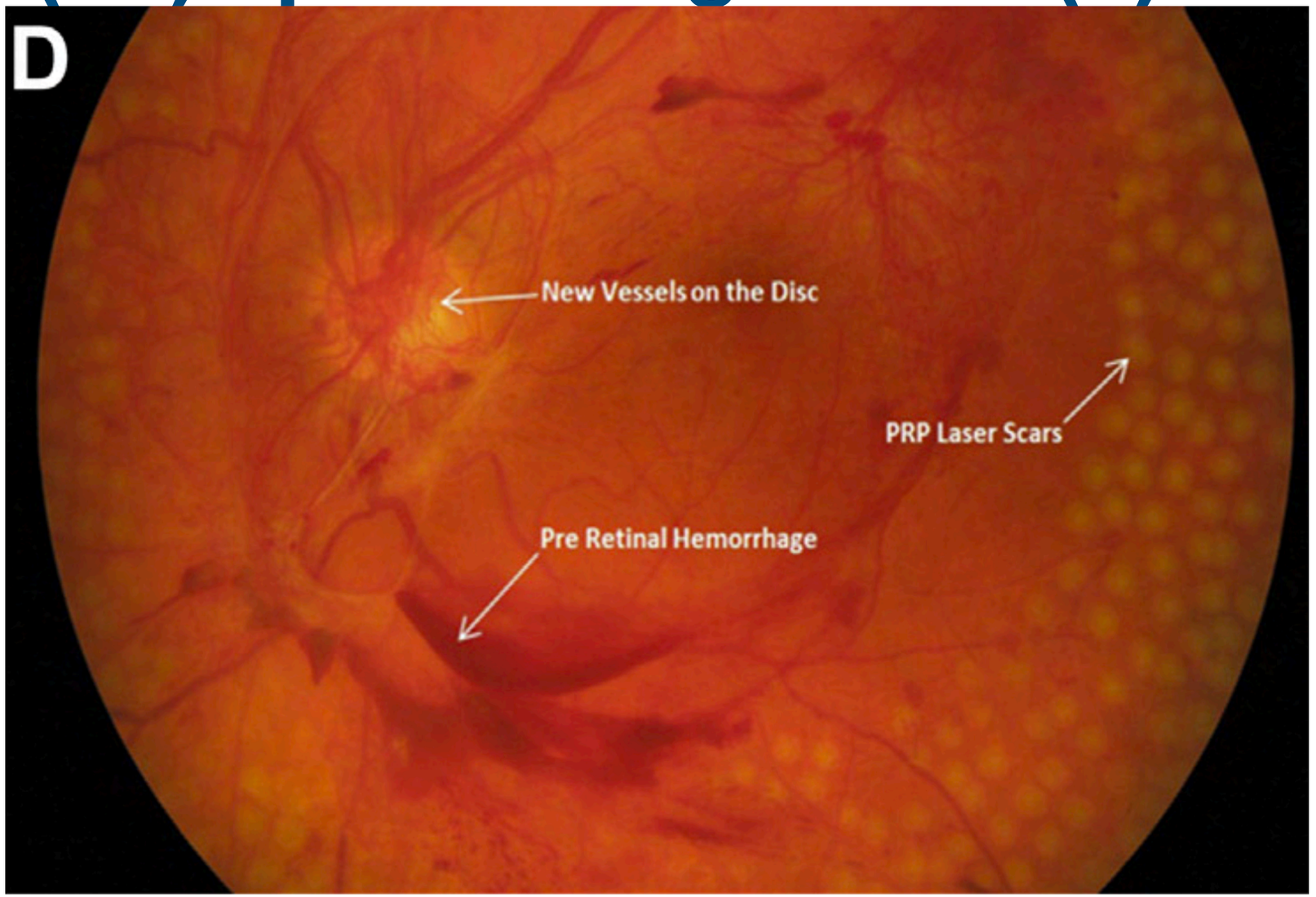
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PDMR (R3)

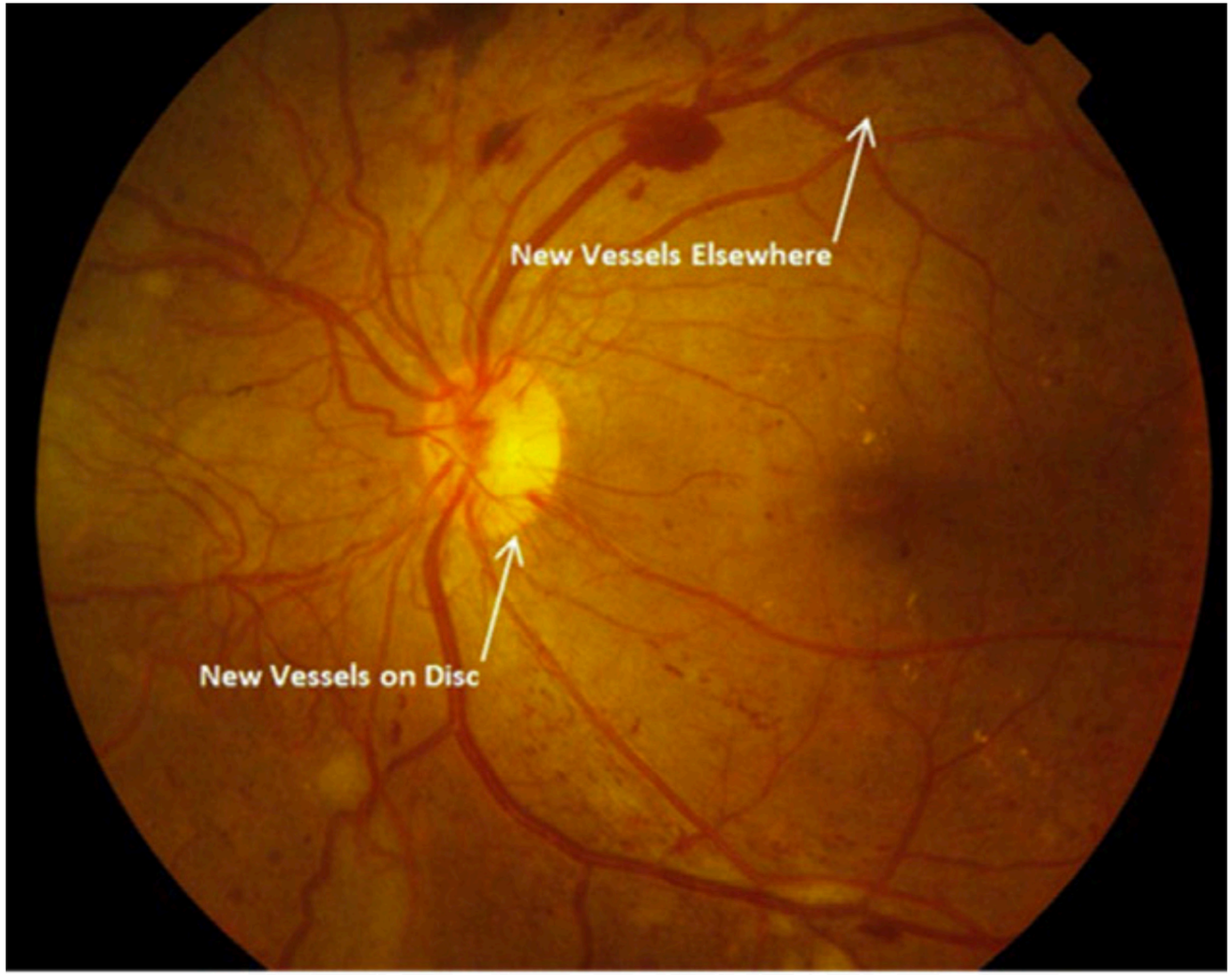


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PDMR (R3)+ photocoagulation (P)

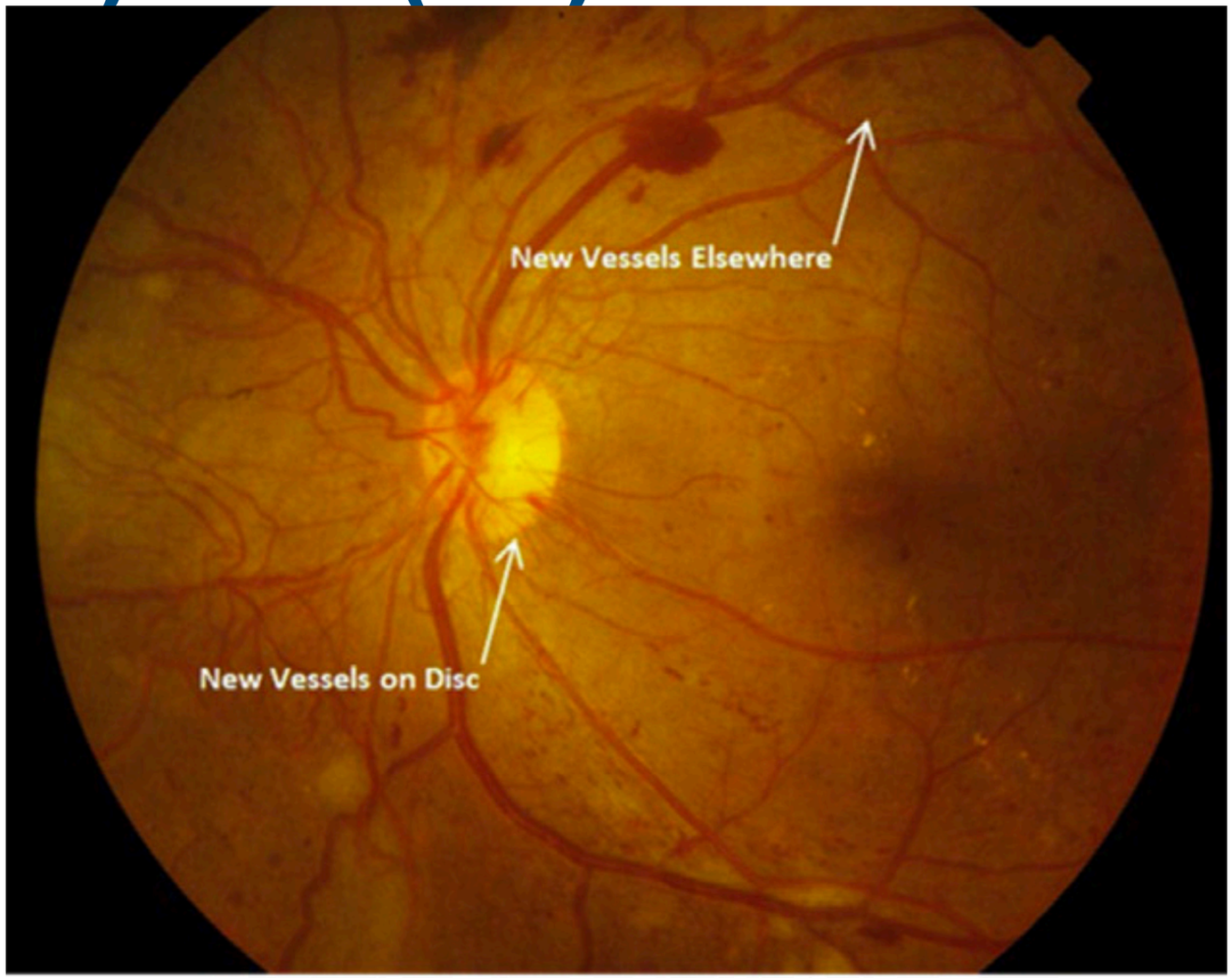


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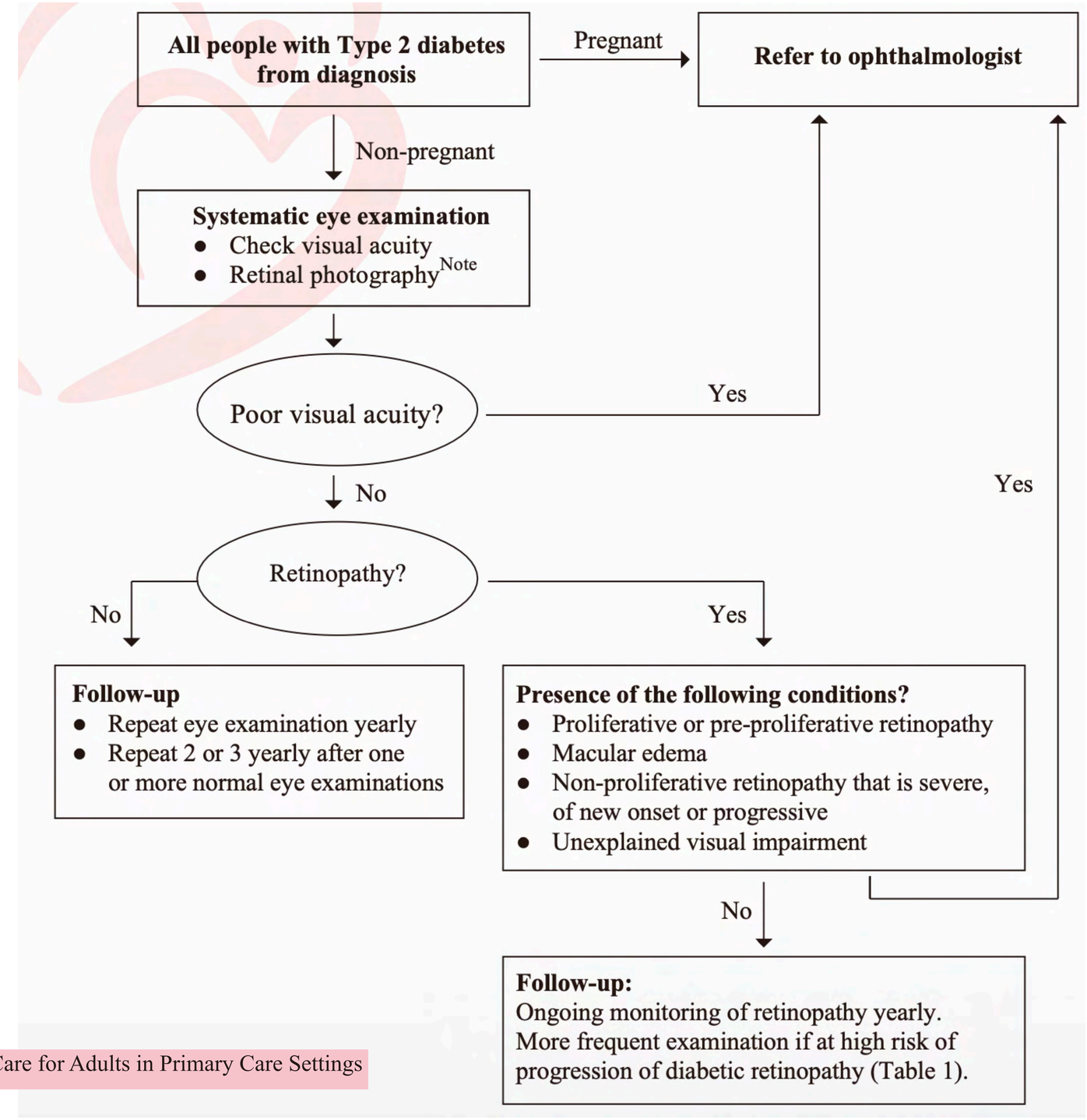
PDMR (R3)+ ME (M1)



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Referral protocol

Grading	Management
R0 No retinopathy	Annual screening with digital fundus photo
R1 Background DR	Annual screening with digital fundus photo
R2 Pre-proliferative DR	Refer to eye clinic for appointment within 13 weeks
R3 Proliferative DR	Refer to eye clinic for appointment within 2 weeks
M1 Maculopathy	Refer to eye clinic for appointment within 13 weeks
P Photocoagulation	Refer to eye clinic if needed
U Unclassifiable	Refer to eye clinic for appointment within 13 weeks


All people with Type 2 diabetes from diagnosis
Pregnant
Refer to ophthalmologist
Non-pregnant
Systematic eye examination
Check visual acuity
Retinal photography Note
Poor visual acuity?
Yes
No
Retinopathy?
No
Yes
Yes
Follow-up
Repeat eye examination yearly
Repeat 2 or 3 yearly after one or more normal eye examinations
Presence of the following conditions?
Proliferative or pre-proliferative retinopathy
Macular edema
Non-proliferative retinopathy that is severe, of new onset or progressive
Unexplained visual impairment
No
Follow-up:
Ongoing monitoring of retinopathy yearly.
More frequent examination if at high risk of progression of diabetic retinopathy (Table 1).

Quiz time!



Quiz time!

- R0M0

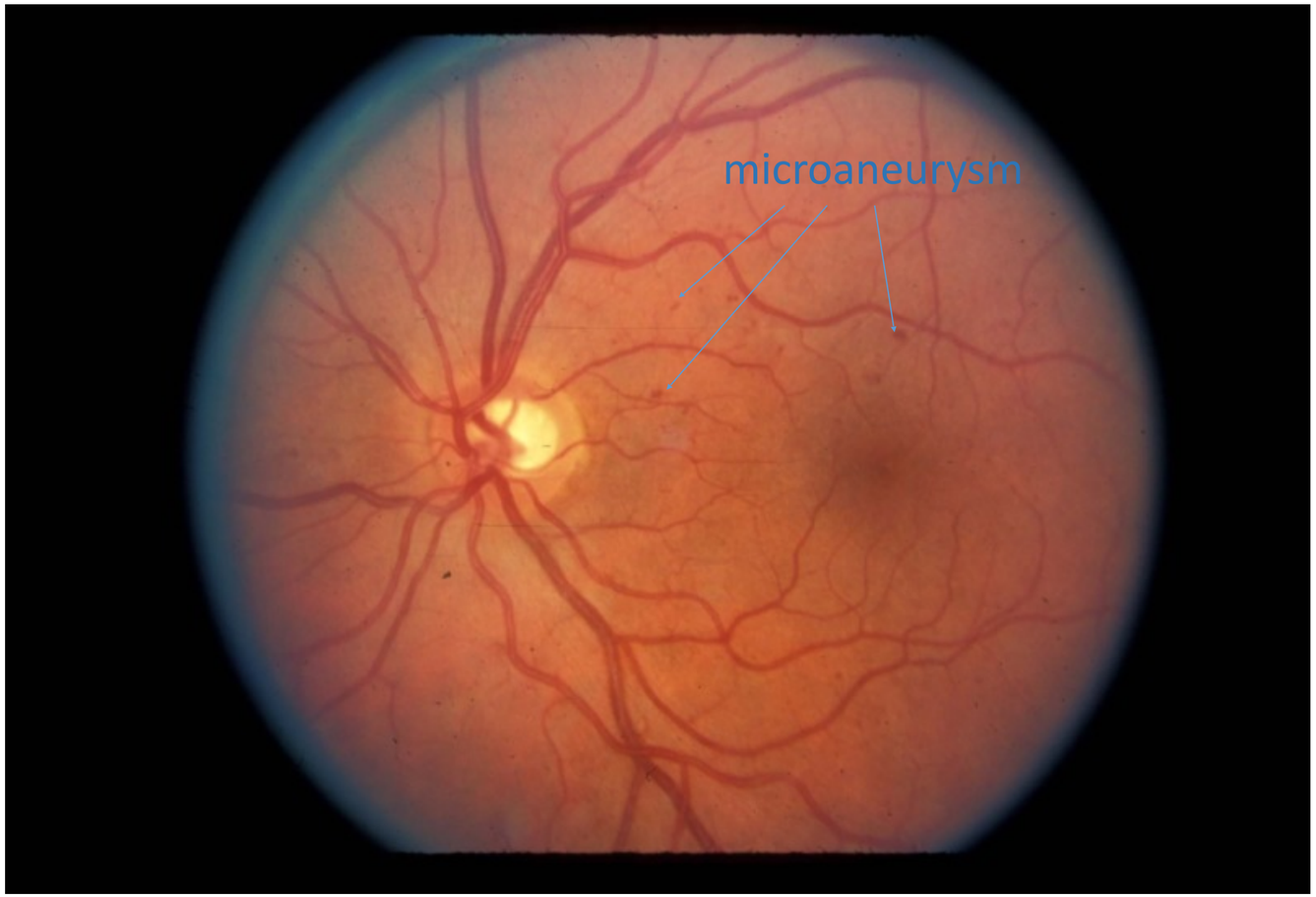


Quiz time!

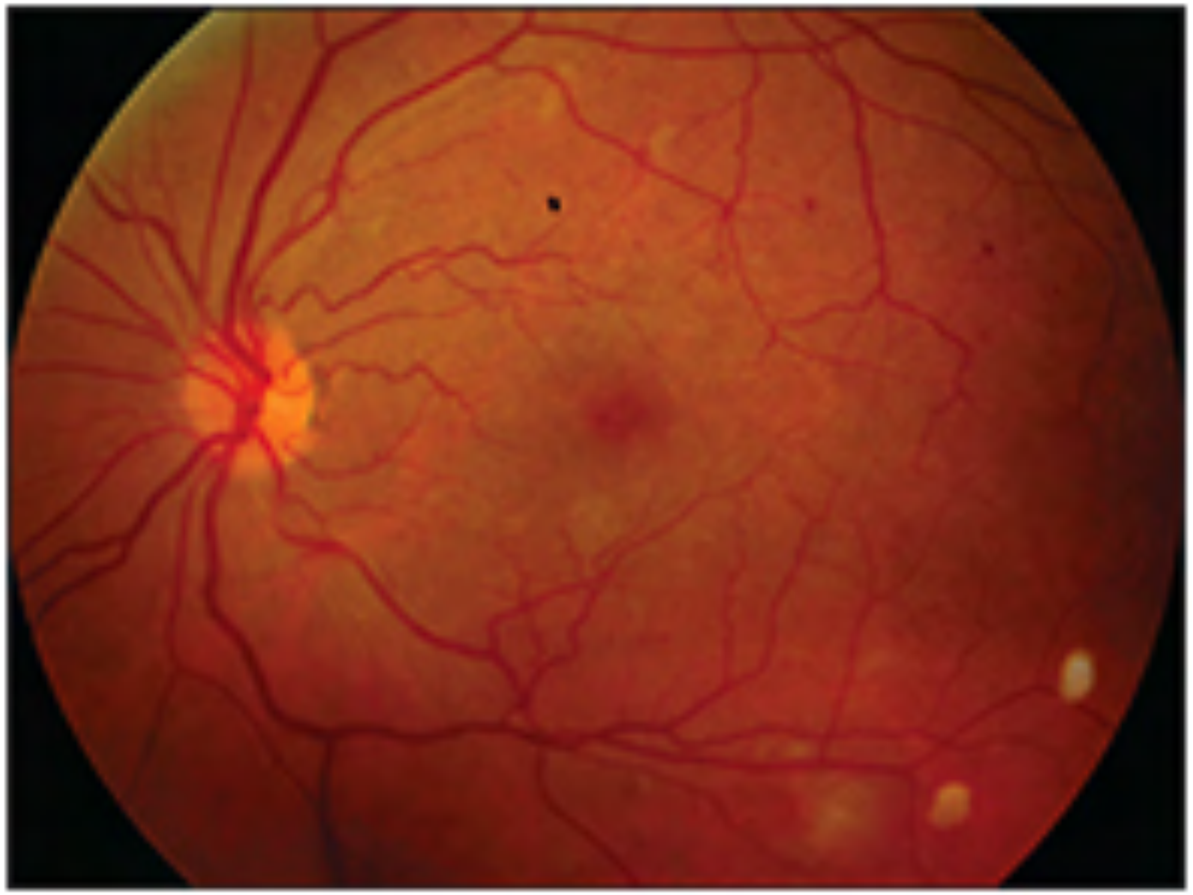


Quiz time!

- R1M0

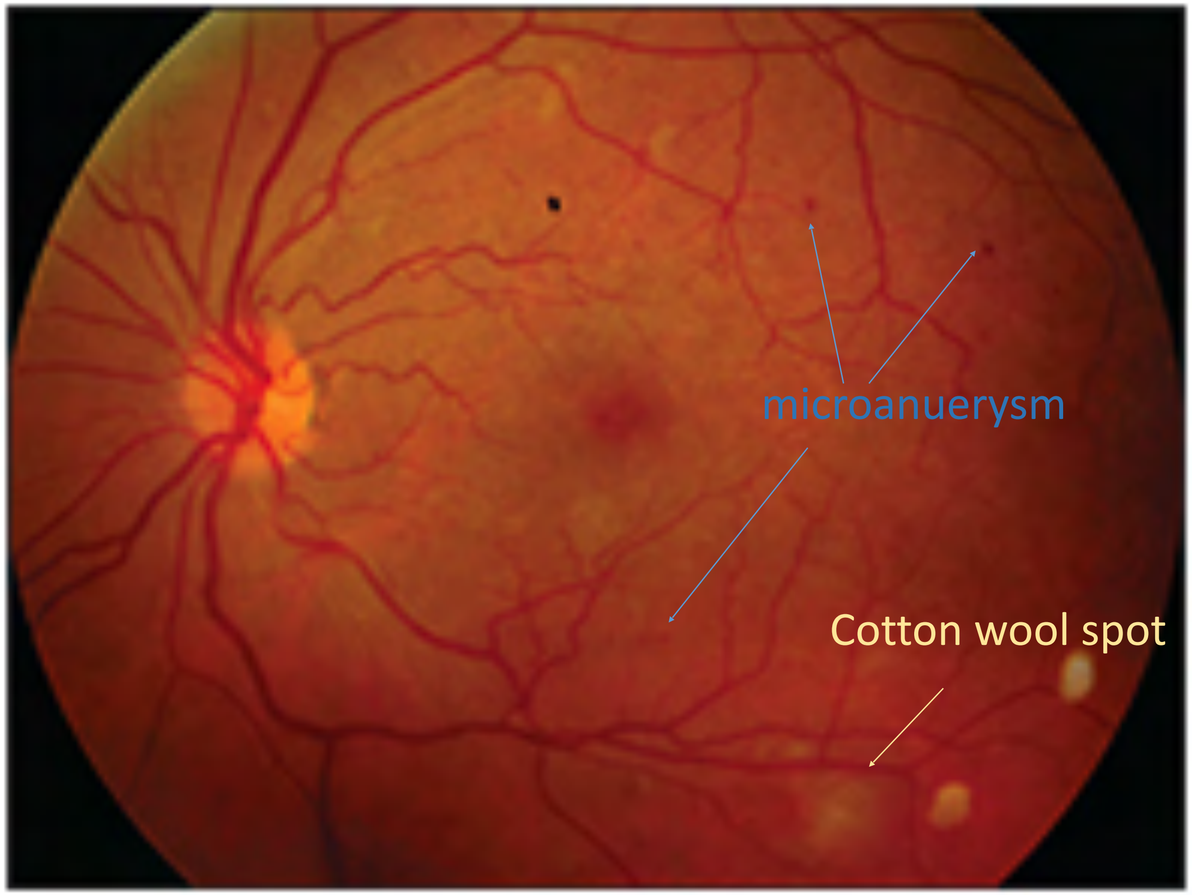


Quiz time!

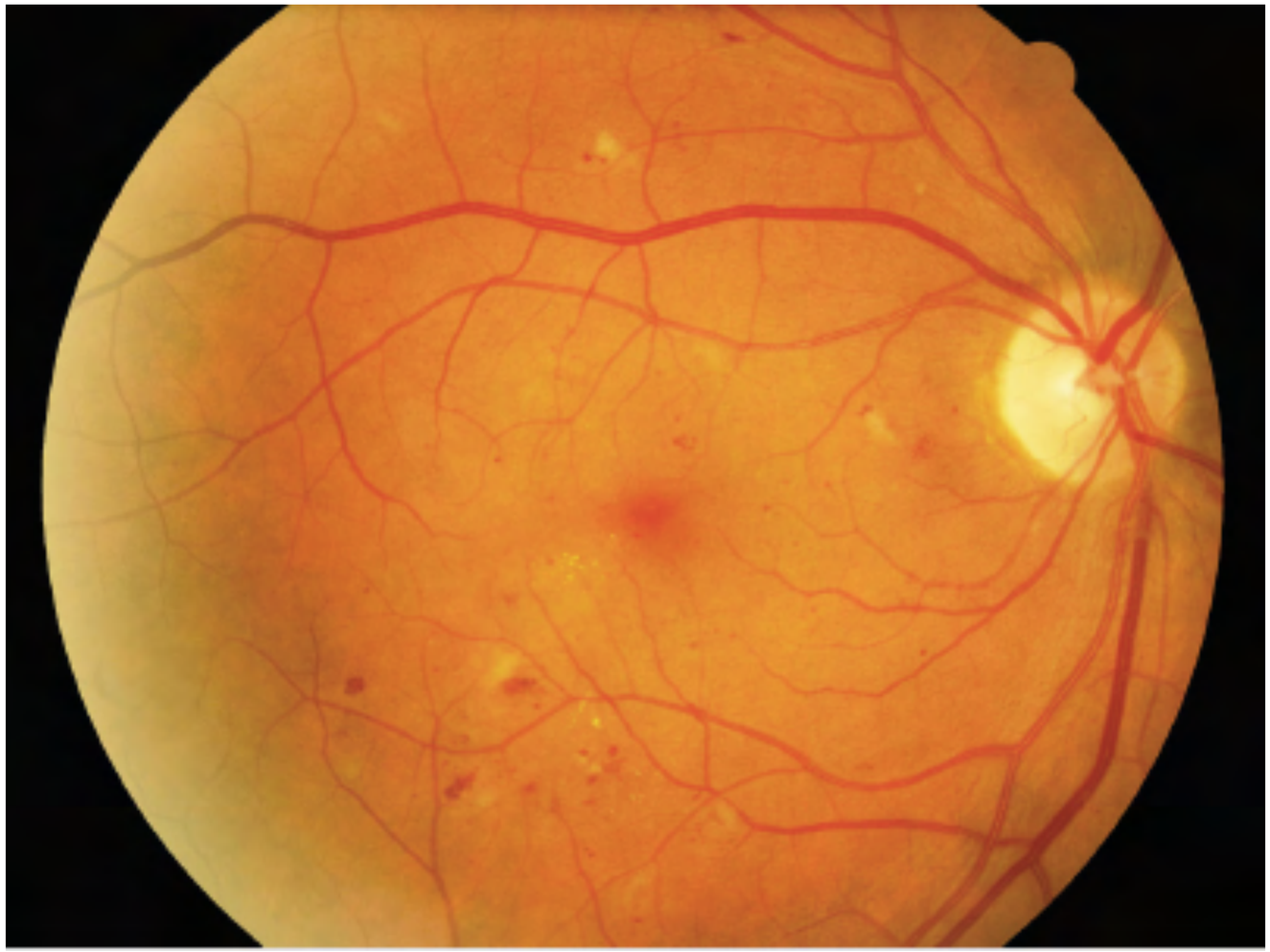


Quiz time!

- R1M0

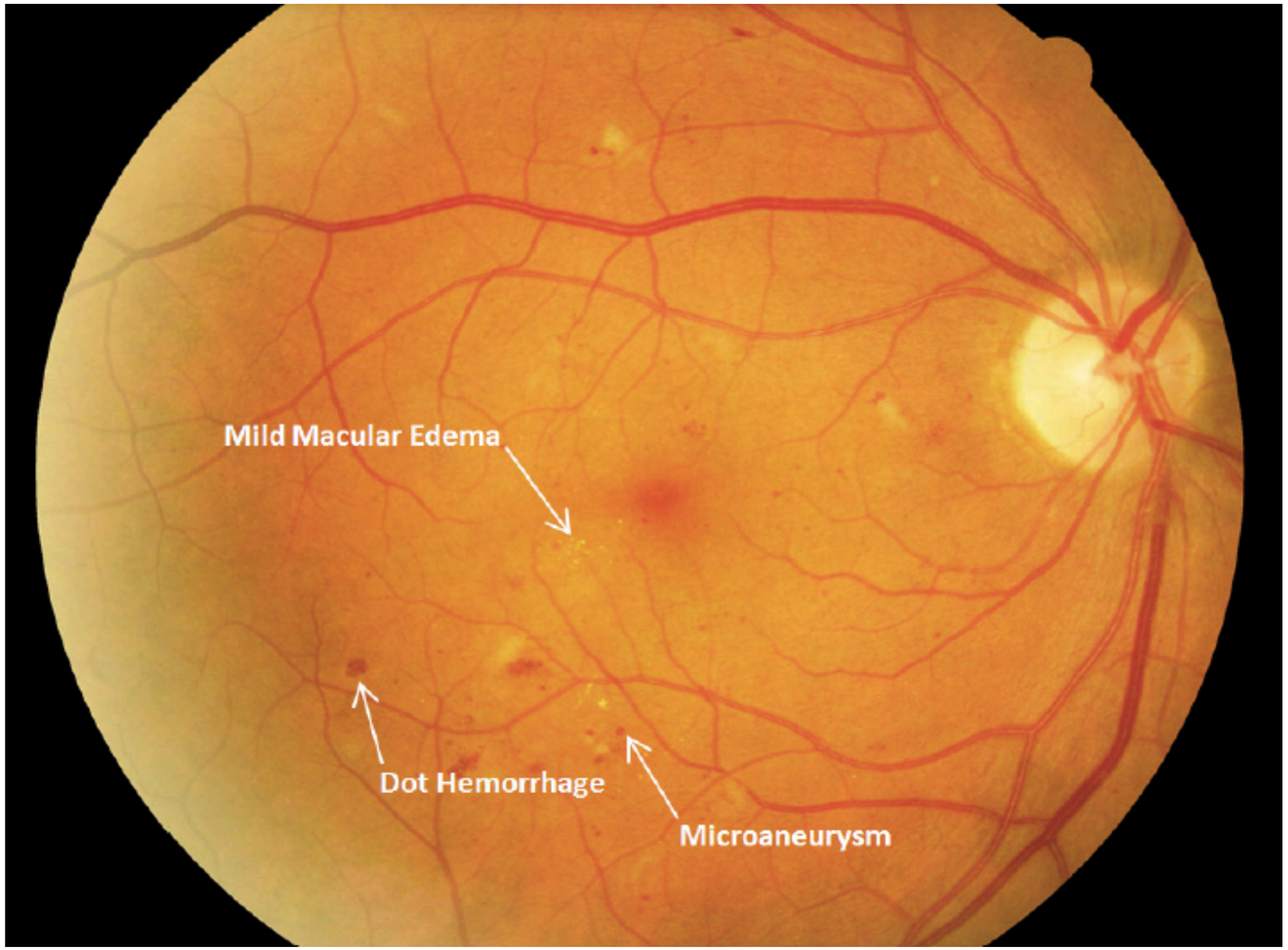


Quiz time!



Quiz time!

- R2M1

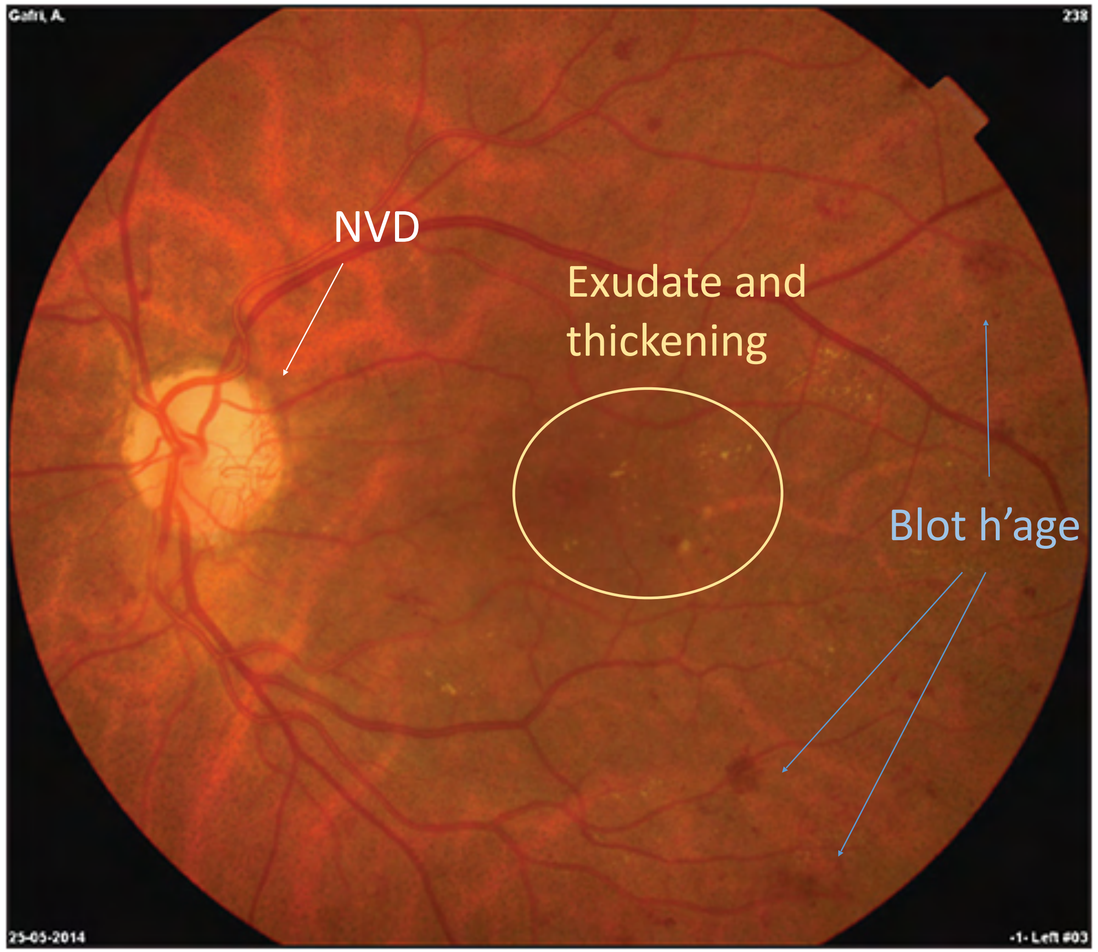


Quiz time!



Quiz time!

- R3M1

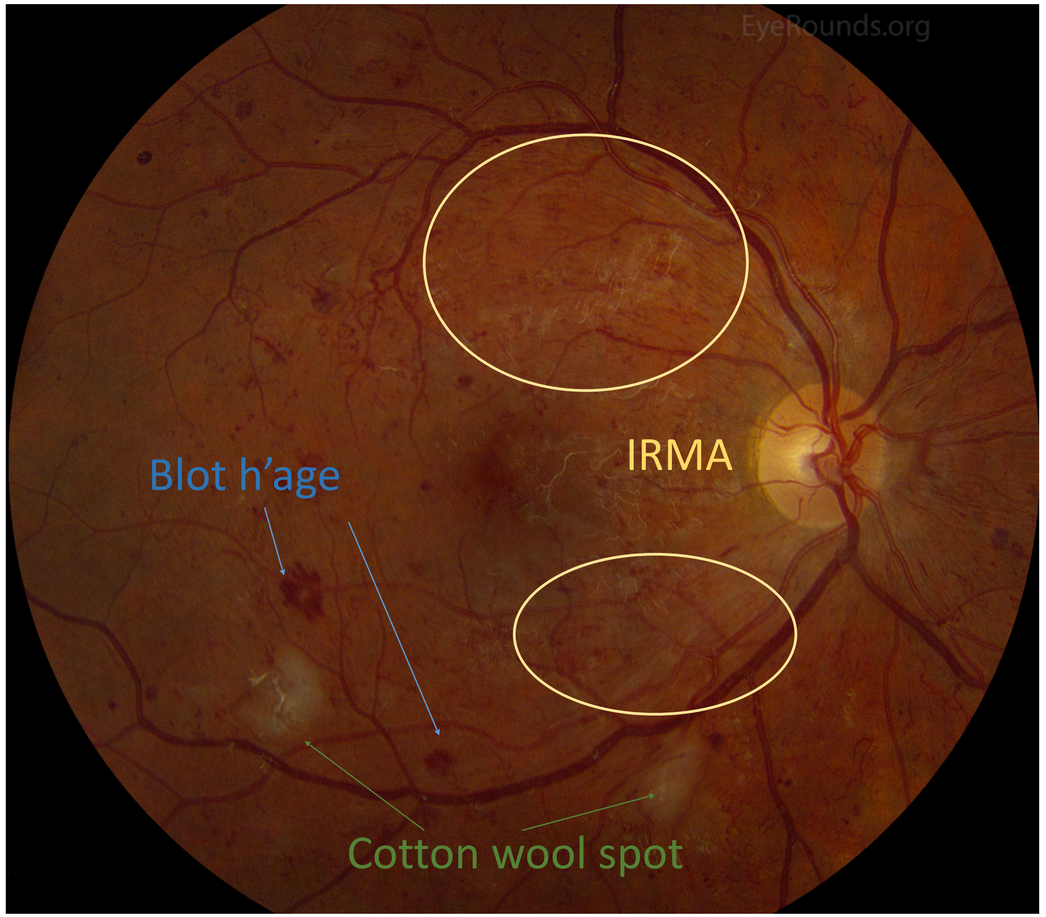


Quiz time!



Quiz time

- R2.5M0



Treatment

- Diabetic retinopathy
  - PRP
    - When:
      - Proliferative disease
      - High risk pre-proliferative disease e.g. opposite eye complicated, before operations
- Diabetic maculopathy
  - Laser – focal/grid
  - Intravitreal injection
    - Anti-vascular-endothelial growth factor
    - Steroid

Summary

- Diabetic retinal complications are the leading causes of blindness amongst working age
- Up to 40% diabetic patients have some form of diabetic retinopathy, although sight-threatening in only around 10% of them
- Region-wide screening programme can identify those who truly need specialist care
  - Standardised classification system
  - Standardised referral protocol

Thank you