Screening for Diabetic Retinopathy in the Central Region of Portugal

Added value of automated “disease / no disease” grading

Luisa Ribeiro, Carlos Manta Oliveira, Catarina Neves, João Diogo Ramos, Hélder Ferreira, José Cunha-Vaz
The 25th EASDec 2015 conference was held in Turin, 26th to 28th June 2015.

This yearly conference aims at promoting “the advancement of knowledge in all aspects of Diabetic Retinopathy”, and in this edition the added value of automated grading using Retmarker technology was presented.

Screening for DR in The Central Region of Portugal was the topic of the communication from Dr. Luísa Ribeiro, which underlined the results obtained of Sensitivity: 97.23% and Specificity: 70.35%.

It was also shown that the sensitivity values are very similar to those obtained when evaluating the agreement between different human graders, 96.83%, or even for the intra-grader agreement: 98.92%. 
SCREENING FOR DIABETIC RETINOPATHY IN THE CENTRAL REGION OF PORTUGAL

ADDED VALUE OF AUTOMATED “DISEASE/NO DISEASE” GRADING

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Diabetic Retinopathy

Worldwide, diabetes is projected to affect 300 million people by 2025.

Diabetic retinopathy is a leading cause of visual impairment in working-age adults.

10% of the world population will likely develop visual impairment secondary to diabetic retinopathy.
Diabetic Retinopathy

Asymptomatic until advanced stages
It can occur at any age

Need to screen and identify eyes that can be treated
- Macular Edema
- Proliferative Retinopathy

All diabetic patients

Diabetic Retinopathy

Screening for DR

WHO Cardinal Principals for Screening

1. Condition should be an important health problem
2. An appropriate screening procedure
3. Treatment available and effective
4. Economic cost is justified
Screening of DR


Photographic screening programs have great value, mostly when the access to ophthalmic care is limited.

Screening of DR

An effective screening programme can distinguish:

- who needs referral to an ophthalmologist for close follow-up and timely treatment
- from those who should only come for a later rescreening
Diabetes in Portugal

**Prevalence** of Diabetes Mellitus is 13% (Age 20-79 years)
- More men (15.6%) than women (10.7%)
- Increase of DM Prevalence with age increase

**Incidence** of Diabetes Mellitus

In Portugal, there are 500-700 new cases of diabetes every year per 100,000 population

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Screening for DR in The Central Region of Portugal

Main Objective

To describe the procedures of a non-mydriatic DR screening program in the Central Region of Portugal and

The added value of the introduction of an automated “disease/no disease” analysis
Screening for DR in The Central Region of Portugal

The DR Screening Program is running since 2001.

Since 2011 it was introduced a central reading center and an automated software analysis.

Target population
All type 1 and type 2 diabetic patients except those already treated / in treatment for DR

Screening for DR in The Central Region of Portugal

• Each of the 5 geographic areas have a portable non-mydriatic retinograph/camera and a technician
• The screening site changes location to cover all the geographic area
• Digital 45 degree fundus photography (2 fields/eye)
• Performed annually
• Refer for treatment
  - maculopathy (M)
  - proliferative diabetic retinopathy (PDR)
Screening for DR in The Central Region of Portugal

Methods

First Phase of Grading – Automated Analysis

Images from the DR screening program are analysed in a Central Reading Center (Coimbra Ophthalmology Reading Center - CORC)

Second Phase of Grading – Human Grading

Only applied to images of the previous identified “disease” cases

Screening for DR in The Central Region of Portugal

Automated Analysis (RetmarkerSR; Retmarker SA, Coimbra, Portugal)

of retinal photographs for DR screening

- 59,626 patients
- Taken between July 2011 and May 2015
- Fundus photo of fields 1 and 2
  - In 5 geographic areas / local health centers

Two possible outputs

- “Disease” (referral for human grading)
- “No disease” (annual rescreening)
Screening for DR in The Central Region of Portugal

First Step of Automated Analysis

1st Assessment (RetmarkerSR)
Red Dots Automated Detection (field 1 & 2)

Patients' Images from Screening Program

Any Red Dots Detected (field 1 or 2)

Disease

2nd Assessment
Human Grading

No Red Dots Detected (field 1 and 2)

No Disease
Reports R0
Annual rescreening

* Conditions: Previous visit between 1 year and 2 years before; if not, uses the same schema as for 1st visits

1st Assessment – RetmarkerSR
Two-step approach (2nd visits workflow *)

1st Assessment (RetmarkerSR)
Red Dots Automated Detection (field 1 & 2)

Patients' Images from Screening Program

Red Dots in field 1

2nd Assessment
Human Grading

Disease

No Dots Detected

2nd Step: Use Previous Images *
Differences Detection +
Red Dots Formation Rate
(only in field 2)

No Need for Treatment
Reports RL
Annual rescreening

No Differences and/or Formation Rate = 0

No Disease
Reports R0
Annual rescreening

If indicated:
NC
Repeat
R0 / RL
Annual rescreening
M / RP
Need for referral

Only in field 2

Red Dots Detected

No Differences and/or Formation Rate

Any Differences and/or Formation Rate

No Need for Treatment
Reports RL
Annual rescreening

Reported with NC
Repeat if indicated
## Human Grading - Grading scale

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
<th>General grading rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>R0</td>
<td>No DR</td>
<td>• No lesions of DR</td>
</tr>
</tbody>
</table>
| RL    | Non proliferative DR (without maculopathy) | • Microaneurysm(s)  
• Retinal hemorrhage(s)  
• Any exudate *not within the definition of maculopathy* |
| M     | Maculopathy | • Exudates within 1 disc diameter (1DD) centred on the fovea  
• Microaneurysms and/or hemorrhages (>5) within 1DD centred on the fovea, and / or  
• Multiple deep, round or blot hemorrhages and larger venous abnormalities within 2DD centred on the fovea |
| RP    | Proliferative DR | • New vessels on the disc (NVD)  
• New vessels elsewhere (NVE)  
• Pre-retinal or vitreous hemorrhage  
• Pre-retinal fibrosis + tractional retinal detachment |
### Human Grading - Grading scale

#### Grading Results

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>NC</td>
<td>Not classifiable</td>
<td>Repeat (if indicated)</td>
</tr>
<tr>
<td>R0</td>
<td>No DR</td>
<td>Annual rescreening</td>
</tr>
<tr>
<td>RL</td>
<td>Non-proliferative DR (without maculopathy)</td>
<td>Annual rescreening</td>
</tr>
<tr>
<td>M</td>
<td>Maculopathy</td>
<td>Referral ASAP – Tx available</td>
</tr>
<tr>
<td>RP</td>
<td>Proliferative DR</td>
<td>Urgent referral – Tx available</td>
</tr>
</tbody>
</table>

### Patient Care Pathway

1. **Selection / call of patients**
2. **DR screening at Primary Care Units**
3. **Coimbra Ophthalmology Reading Center (CORC)**

- **Cannot grade**
  - Poor image quality
  - Obscuring lesions
- **R0**
  - No lesions of DR
- **RL**
  - Non-proliferative DR
- **M**
  - Maculopathy
- **RP**
  - Proliferative DR

- **Referral to the Ophthalmology Department**
  - ASAP if maculopathy
  - Urgent if proliferative retinopathy

- **Repeats screening ASAP (if indicated)**
- **General Practitioner informed of the result**
- **Repeats screening in 1y**
Screening for DR in The Central Region of Portugal

Quality Control
Automated Analysis of DR

Results
Automated grading of DR may safely reduce the burden of “disease/no disease” grading in DR screening programmes

- Sensitivity: 97.23%
- Specificity: 70.35%

Screening for DR in The Central Region of Portugal

Quality Control
Human Grading of DR

Inter Grader Agreement (number of cases = 1864)
- Referral vs No referral – 96.83%
- All levels – 82.94%

Intra Grader Agreement (number of cases = 279)
- Referral vs No referral – 98.92%
- All levels – 91.04%
## DR Screening – Results

Jul 2011 – Mai 2015

<table>
<thead>
<tr>
<th></th>
<th>Eyes</th>
<th>NC</th>
<th>R0</th>
<th>RL</th>
<th>M</th>
<th>RP</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL</td>
<td>119,253 (59,626 pts)</td>
<td>4,486 (3.8%)</td>
<td>87,944 (73.7%)</td>
<td>24,090 (20.2%)</td>
<td>2,547 (2.1%)</td>
<td>186 (0.2%)</td>
</tr>
</tbody>
</table>

**RESULTS**
- **R0; 73.7%**
- **RL; 20.2%**
- **NC; 3.80%**
- **M; 2.1%**
- **RP; 0.2%**
Screening for DR in The Central Region of Portugal

Main Conclusion

The implemented automated analysis with the RetmarkerSR, together with a simplified grading scale, identifies well DR vision-threatening complications while decreasing human burden and costs.

Publications

