Diabetic retinopathy (DR), a window for prediction of potential stage of diabetic kidney disease (DKD) and its progression: An analysis of real-world data

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PURPOSE

• To substantiate clinical correlation between stages of DR and DKD and establish risk factors impacting the association in real world patient data.
• This study has supported the development of an AI based model which predicts the potential stage of DKD in patients diagnosed with certain severity of DR.
• An analysis such as this can assist in early detection of renal dysfunction due to DKD leading to early intervention by the nephrologist to manage the disease efficiently.

METHODS

• Data were collected from a total of 366 patients.
• Data were collected in the form of fundus images and demographic data.
• Inclusion criteria for population under evaluation:
  - History of diabetes, DR and DKD.
  - Availability of fundus image data and nephrology parameters such as urine protein, serum creatinine and estimated glomerular filtration rate (eGFR).
• Fundus data were collected from FF450 (ZEISS, Jena, Germany) along with DR stage annotations, done by the ophthalmologist, from VISUHEALTH platform (ZEISS, Jena, Germany).
• The association between stages of DR and DKD at the baseline visit of patients was analyzed using the chi-square test.
• A multivariate logistic regression model was used to identify significant risk factors as predictors of DKD stage.
• Follow up data from one visit for each patient were used for progression analysis.

RESULTS

• p-value = 0.035 indicates association between clubbed stages of DKD [Early DKD Stage (Stage 1, 2, 3A and 3B) and Advanced DKD Stage (4 and 5)] and severities of DR.
• The p-value of 0.023 is indicative that the severity of DR and DKD progress in a similar fashion (Table 2).
• Odds Ratio (OR) of the following:
  - Age = OR 1.03, p-value 0.003
  - History of hypertension = OR 7.28, p-value <0.001
  - Duration of hypertension = OR 1.10, p-value < 0.001
  - HbA1C = OR 0.79, p-value <0.001
  - Presence of urine protein = OR 19.67, p-value <0.001
are indicative that these parameters are significant risk factors towards DKD stage prediction.

CONCLUSIONS

• A significant association between DR stages and clubbed DKD stages, as well as significant association between DR and DKD progression.
• Such an association in real world data can assist the ophthalmologists in timely referral of long-standing diabetic patients to the nephrologists before the patients progress to end-stage renal disease (ESRD) and eventually renal replacement therapy.
• Association between DR and DKD progression can facilitate an early detection of DKD stage through non-invasive procedures like fundus imaging and urine dipstick test, leading to better management of renal diseases by clinicians.

Table 1: Association of baselines DR and (clubbed) DKD Stages

<table>
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<tr>
<th>DKD Stage at baseline</th>
<th>DR Stage at Baseline</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>Row Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1, 2, 3A, 3B)</td>
<td></td>
<td>18</td>
<td>12</td>
<td>55</td>
<td>113</td>
<td>59</td>
<td>257</td>
</tr>
<tr>
<td>(4, 5)</td>
<td></td>
<td>10</td>
<td>0</td>
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<td>47</td>
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<td>109</td>
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</tbody>
</table>

Chi-square test of association = 10.3, df = 4, p-value = 0.035

Table 2: Association of DR progression and DKD progression

<table>
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<th>DR Progression</th>
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<th>Row Total</th>
</tr>
</thead>
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</tr>
</tbody>
</table>

Chi-square test of association = 5.1, df = 1, p-value = 0.023

Table 1: Chi Square Analysis to evaluate association between DR stages and stages of DKD

Table 2: Chi Square Analysis to evaluate association between DR progression and DKD Progression