CLINICAL STUDY

Detection and prevalence of early diabetic retinopathy in juvenile diabetics with diabetes for 10 years or more

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Abstract

Purpose **To compare clinical examination using green light with clinical examination using white light in detecting early diabetic retinopathy (DR) in juvenile diabetic patients with disease for 10 or more years.**

Methods **All patients were examined clinically using both green light and white light to determine the presence of DR. Each patient underwent seven-field fundus photography, which was used as the defined standard against which the clinical examinations were compared and also to determine the prevalence of DR. Data on age at diagnosis, duration of diabetes mellitus, recent HbA_{1c} levels, treatment for systemic hypertension and microalbuminuria were obtained from medical records.**

Results **When compared with the defined standard, fundal examination with green light was more sensitive, more specific and had higher predictive values than examination with white light in the detection of early DR. The overall prevalence of DR was 44%, which in all cases was classified as minimal to mild background DR. Patients with DR had significantly higher mean HbA_{1c} levels than those without ($p = 0.016$). There was no significant association between the prevalence of DR and age at time of examination or diagnosis, duration of diabetes, patient gender, microalbuminuria levels or treatment for systemic hypertension.**

Conclusion **Fundal examination with green light is better than white light in detecting early DR in juvenile diabetics with duration of disease of 10 years or more. Furthermore the presence of DR is associated with poorer diabetic control. Due to coincident lifestyle changes and the probability of long duration of disease, accurate detection of early DR in juvenile diabetics with diabetes for over 10 years is important.**

Key words Diabetic retinopathy, T_1 diabetes mellitus

While type I diabetes mellitus may occur at an early age, diabetic retinopathy (DR) does not usually develop before 13 years of age or within 4 years of onset of the disease.[1–3] The most common early sign of DR seen in juvenile patients is retinal microaneurysms, which by definition are less than 125 μm in their longest dimension and correspond to non-sight-threatening background DR.[1–7] The sensivity and specificity of the methods of detection of DR depend on the technique used and the person examining for retinopathy, while the two gold standards are seven-field stereoscopic fundus photography and fluorescein angiography.[8–14] No previous studies have tested the sensitivity and specificity of green (red-free) light relative to white light in detection of DR when both are compared with a defined standard.

Juvenile diabetics have an increased risk of DR by virtue of their early age at diagnosis resulting in prolonged duration of disease, which may be complicated by poor metabolic control, development of renal failure and hypertension.[15–18] Juvenile diabetics can have periods of poor diabetic control corresponding to leaving school, starting employment or entering tertiary education.[19] In view of recent reports which demonstrated that good metabolic control reduces the incidence and progression of DR, accurate detection of the earliest signs of DR in juvenile diabetics has clinical implications.[21,22]

Materials and methods

Our Lady's Hospital for Sick Children has had established services for diabetic patients for about 30 years, including a diabetic day centre and a dedicated diabetic chart system. The hospital has links with the Ophthalmology Department of the Royal Victoria Eye and Ear Hospital, which is the regional eye unit for the Eastern and Midland areas of the country. Its

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consultant staff includes four retinal specialists and it has a catchment population of about 900 000.

Patients with diabetes mellitus for 10 years or more were identified from the hospital records of Our Lady's Hospital and invited to attend for clinical examination. After assessment of Snellen visual acuity, dilated fundal examinations to detect DR were performed on each patient by two ophthalmologists (M.C. and D.W.) using slit-lamp biomicroscopy and direct and indirect ophthalmoscopy, one using green light, the other white light. To reduce any bias of an examiner becoming accustomed to using one colour light only, the type of light used by an examiner was determined beforehand by chance. The examiners classified the DR according to whether the clinical findings were better than, equal to or worse than one of four standard photographs from the Retinopathy Grading Centre (RGC). The least and worst grades of retinopathy corresponded to no DR and severe proliferative DR respectively. All patients underwent 30° seven-field fundal photography as described by the ETDRS protocol and these were graded in the RGC.[7]

Patients' medical records were reviewed for data on diabetic treatment, HbA_{1c} levels, age at diagnosis, duration of disease, microalbuminuria levels and treatment for systemic hypertension. HbA_{1c} levels recorded in the diabetic charts within 3 months of the study period were used and were estimated using high-performance liquid chromatography. Duration of diabetes was calculated from the date of diagnosis in the clinic to the study examination, rounded to the nearest month. The mean of all the patient's microalbuminuria levels taken over the 18 months preceding the study was used, while a patient was considered to have systemic hypertension if the diagnosis had been made previously and treatment commenced.

The significance of associations between DR and the factors outlined above was determined using Student's *t*-test for normally distributed continuous variables, the Mann–Whitney *U*-test for continuous variables with a skewed distribution and the chi-square test for categorical variables.

Results

A total of 220 diabetic patients were registered with the diabetic unit of Our Lady's Hospital, of whom 40 had had diabetes for 10 years or more and 36 attended for clinical examination including seven-field fundus photography. Two patients were excluded from the study, as the fundus photographs were not assessable. Thus the participation rate was 85% and 17 (50%) of the remaining 34 patients were female. All patients were on subcutaneous insulin therapy.

Detection of DR using green light versus white light

Clinical examination with green light was more sensitive and more specific than examination with white light in the detection of DR when compared with the defined standard of seven-field fundus photography (Table 1).

Table 1. *Detection and prevalence of early diabetic retinopathy (DR) in juvenile diabetics with diabetes for 10 years or more: comparison of green light with white light in detection of DR against the reference standard of seven-field fundus photography*

	Clinical examination with green light	Clinical examination with white light
No. of patients	34	34
Sensitivity [d/(b+d)]	0.46 (7/15)	0.33 (5/15)
Specificity [a/(a+c)]	0.95 (18/19)	0.79 (15/19)
Predictive values		
Positive [d/(c+d)]	0.87 (7/8)	0.55 (5/9)
Negative [a/(a+b)]	0.69 (18/26)	0.60 (15/25)

a, no DR detected either by fundus photography or by clinical examination; b, DR detected by fundus photography but not by clinical examination; c, DR detected by clinical examination but not by fundus photography; d, DR detected by fundus photography and by clinical examination.

Prevalence of DR and its association with HbA_{1c} levels

The prevalence of DR was 44% (n = 15) and in all cases was present as background DR. Using the data from the fundal photographs in 13 cases (38%) the only sign of DR was the presence of microaneurysms in the worse eye. The remaining 2 cases (6%) had ETDRS level 35, corresponding to mild background DR in the worse eye. The mean HbA_{1c} levels were significantly higher in patients with DR in comparison with those without.

Association between DR, patient age at examination and at diagnosis, duration of diabetes, gender, microalbuminuria levels and treatment for systemic hypertension

There was no significant association between the prevalence of DR and patient age at the time of examination or at diagnosis, nor with duration of disease. A higher, but insignificant proportion of patients without DR was female in comparison with patients with DR (Table 2). None of the 26 patients with data on microalbuminuria had abnormal urinary excretion of albumin nor was there any difference in mean

Table 2. *Detection and prevalence of early diabetic retinopathy (DR) in juvenile diabetics with diabetes for 10 years or more: association between DR and potential predictive variables*

	DR (+) (n = 15)	DR (–) (n = 19)	p value
HbA_{1c} levels (%), mean (SD)	9.0 (1.45)	8.1 (1.07)	0.016
Patient age at examination (years)			
Median	16.75	16.7	0.342
Range	11.7–22.6	11.4–19.4	
Patient age at diagnosis (years)			
Median	2.75	3.20	0.373
Range	0.25–12.4	1.0–8.6	
Duration of diabetes mellitus (years)			
Median	12.25	11.35	0.438
Range	10.1–16.5	10.0–16.5	
Sex, n (%)			
Male	9 (60)	8 (42)	0.300
Female	6 (40)	11 (58)	
Microalbuminuria (mmol/l), mean (SD)	1.32 (1.22)	1.60 (1.34)	0.282

microalbuminuria levels in patients with and without DR (Table 2). None of the patients was on treatment for systemic hypertension.

Discussion

To our knowledge, this is the first study to demonstrate an increased sensitivity of green light versus white light in the clinical detection of early DR. This increased sensitivity of green light may be due to the fact that the earliest lesions of DR are microaneurysms, which by nature of their red colour are more apparent in red-free light. The sensitivity, specificity and predictive values of clinical examination with white light found in this study are similar to those in two previous larger hospital-based studies, one of which concentrated on juvenile diabetics.[2,14] Both forms of screening used in this study fall short of the St Vincent Declaration criteria, but this relatively low sensitivity in detecting the microaneurysms of early DR may be due to their small size and the absence of other associated changes of more severe DR.[23] An increased sensitivity of clinical examination in the detection of more severe forms of DR has been documented.[8,10,11,13,14]

The exclusion from this study of juvenile diabetics with disease for less than 10 years was based on evidence from prior prevalence studies.[1–6] These detected minimal DR before puberty or 10 years' disease duration while DR prevalence varied between 10% to 93% after 10 years' duration or the onset of puberty.[1–6] The variation between the prevalence in this report and previous studies may be due to different examination techniques, methods of treatment or racial characteristics.[1–6] While no formal assessment of puberty was carried out on our participants, and patient age at the time of examination was not associated with higher prevalence of DR, hormonal changes producing anti-insulin effects may increase the risk of developing DR during puberty.[2,3,6]

HbA_{1c} level, an indicator of poor control, was significantly associated with an increased prevalence of DR, which correlates with the findings of several previous studies in both juvenile- and adult-onset patients with insulin-dependent diabetes (IDDM).[2,3,6,17,18] Good diabetic control, as highlighted by recent reports, reduces the incidence and progression of DR.[20,21] Leaving school, starting employment or entering tertiary education are stressful events, may result in poorer short- and long-term diabetic control in juvenile diabetics and often coincide with over 10 years of diabetes and completion of puberty.[19,20]

Age at diagnosis or gender are not associated with DR in this or previous studies of juvenile diabetics.[2,3,6,17,18] The relatively short average disease duration may explain the lack of association between disease duration, microalbuminuria and systemic hypertension and DR in this study, as these parameters are significant in long-term studies of all types of insulin-dependent diabetics.[15–18,24] However, all juvenile diabetics by virtue of their early age at diagnosis have the possibility of having a prolonged duration of diabetes with its associated morbidity and mortality.[15]

Conclusions

Fundal examination with green light is better than white light in detecting early DR in juvenile diabetics with duration of disease of 10 years or more. Furthermore the presence of DR is associated with poorer diabetic control. Due to coincident lifestyle changes and the probability of long duration of disease, accurate detection of early DR in juvenile diabetics with diabetes for over 10 years is important.

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