The Prevalence of Retinopathy in the Insulin-requiring Diabetic Patients of an English Country Town

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Summary

A population-based survey of the insulin-requiring diabetics of a representative population was carried out. The overall prevalence of diabetes was 10.9/1000, that of insulin-requiring diabetes 4.1/1000. No retinopathy was found in 59%, background retinopathy was found in 33% and proliferative and advanced disease in 8%, diabetic maculopathy was present in 6.8% and the prevalence of potentially treatable disease undetected was 7.6%. Significant risk factors identified for retinopathy were increased duration of diabetes and elevated diastolic blood pressure, those for maculopathy an increased age at examination and onset of diabetes and an elevated systolic blood pressure.

The care and treatment of diabetic patients form a significant and important part of the workload of ophthalmic departments and there are indications that this workload will increase. Appropriate retinal photo-coagulation is established as being effective in preventing visual loss.^{1,2,3} The main necessities are the detection of those at risk and the provision of adequate treatment. Planning for manpower and resources requires a knowledge of the problem and information has been provided by surveys in the United Kingdom which have been carried out, mainly at specialised hospital clinics.

In an attempt to contribute to this knowledge we have carried out a population-based survey of eye disease in the insulin-requiring patients of an English town. The results from the survey have been used to estimate the prevalence of diabetic retinopathy and to examine the relationship between retinopathy and five potential risk factors, viz. age at examination, age at onset, duration of diabetes, systolic blood pressure and degree of diabetic control.

Method

Population

The population chosen for this survey was that of Melton Mowbray, a country town in Leicestershire. An unusual situation exists there in that virtually all of the town and most of the surrounding district is served by a single twelve-doctor practice working from the same premises. The population is geographically well defined and has been shown to be demographically representative of that of England and Wales.⁴ A computerised age-sex register of the entire population registered with the practice (approx 32,000) has been established by the Leicester University Department of Community Health. The diabetic patients were identified from the records of prescriptions for insulin and other hypoglycaemic agents, together with prescriptions for blood and urine testing kits.

The insulin-requiring patients known to the practice on January 1st 1987 were contacted and offered an ophthalmic

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examination at the Melton Mowbray War Memorial Hospital or at home if a visit to the clinic was not possible.

Examination

The patients who agreed to be seen were all interviewed between January 1987 and December 1987 using a pre-prepared questionnaire to record basic information regarding both their diabetic and general medical histories.

The examination, carried out by an ophthalmologist and an optician, consisted of:-

- (a) a full ophthalmic refraction and recording of the best corrected visual acuity measured by Snellen chart at six metres.
- (b) the measurement of the intra-ocular pressure with a Perkins hand-held tonometer in both the sitting and supine positions.
- (c) the measurement of the systolic blood pressure, both supine and standing, with a Copal U-231 Automatic Sphygmomanometer which has been shown to be accurate and useful for epidemiological studies.⁵
- (d) slit lamp examination of the anterior segments.
- (e) after maximum mydriasis, a retinal examination carried out with the direct and indirect ophthalmoscope to record the presence or absence of background retinopathy, diabetic maculopathy, proliferative retinopathy, vitreous haemorrhage or advanced diabetic eye disease such as traction retinal detachment.
- (f) stereo fundus photographs of seven standard thirty degree retinal fields were taken with a Zeiss fundus camera.
- (g) Venous blood was taken for the measurement of glycosylated haemoglobin (Hb A₁) to estimate the degree of diabetic control over the four to eight weeks prior to examination.

Grading of fundus photographs

The scheme adopted for grading of the retinal photographs was that used by the Wisconsin Epidemiological Survey of

Table 1 *Summary of scheme used for photographic grading*

Retinography grades	
1	no retinopathy
1.5-5	background retinopathy
6	fibrous proliferation
6.1	photocoagulation burns
6.5-7	proliferative retinopathy
8	advanced disease

Table II *Age-specific prevalence rates of insulin-requiring diabetics*

Age (yrs)	Male	Female	Total	Prevalence (per 1000)
0-19	7	4	11	1.1
20-39	20	17	37	3.9
40-59	21	16	37	5.0
60+	26	20	46	7.0
Total	74	57	131	4.1

Diabetic Retinopathy summarised in Table I.⁶ In this scheme the stereo slide pairs of each retinal field is examined for diabetic retinopathy and a grade of severity determined by comparison with a set of standard slides.⁷

The highest (i.e. worst) field grade of each eye was taken as the overall grade for that eye. The grading was carried out in a masked fashion after an initial inspection of the slide sets to ensure their quality. A second grading was carried out at a later stage and if the gradings did not concur then a further, independent grader was used, and a final grade agreed upon. This method of grading the slides was used because it was found to give a reproduceable, overall retinopathy grade for each eye.

In addition to this overall grading, the presence of diabetic maculopathy was recorded separately. The criteria of The Early Treatment Diabetic Retinopathy Survey³ were used, namely, the presence of discrete macular oedema or hard exudates within one disc diameter of the centre of the macula. Evidence of focal macular photocoagulation, presumed to have been directed at diabetic maculopathy, was recorded as treated maculopathy.

Statistical analysis

The differences between the means were tested using one way analysis of variance and the t test. Risk factors for retinopathy were assessed using a multinomial version of logistic regression known as proportional odds regression⁸ and the same risk factors were assessed for maculopathy by logistic regression.

Results

One hundred and thirty one insulin-requiring patients were identified from the practice records (4.1 per thousand) and two hundred and nineteen non insulin-requiring diabetic patients (6.8 per thousand). The overall prevalence rate of diabetes was thus 10.9 per thousand in this population.

The mean age of the insulin-requiring patients was 48 yrs (range 6-81), 74 (57.9%) were males and 57 (42.1%) were females. The mean age at diagnosis of diabetes was 33 years (range 1-69 yrs) and the mean duration of diabetes was 15 yrs (range 1-52 years). The age-specific prevalence rates are shown in Table II. Of this total of 131 patients, 113 (86%) agreed to an ophthalmic examination. Relevant details of the attenders and non-attenders are summarised in Table III. The non attenders were younger ($p < 0.01$) but there was no significant difference in the age at diagnosis ($p = 0.09$) or duration ($p = 0.1$) of diabetes. We were unable to grade seventeen of the patients examined by the photographic method, only a clinical grading was possible. This was either because they had been examined at home where it was not feasible to carry out fundus photography, or that the

photographs taken were not of a high enough quality to allow for accurate grading. There was no statistical difference for age at examination, age at diagnosis and duration of diabetes for those with and without photographic grades.

Thirty four patients (30%) regularly attended a hospital ophthalmic clinic and fifteen (13.2%) had been treated with laser photocoagulation. In addition another three patients had undergone fluorescein angiography but had not required treatment.

Photographic grades of retinopathy

The age-specific prevalence of retinopathy levels for each eye graded photographically is shown in Table IV and by duration of diabetes in Table V.

One hundred and ninety one eyes of 96 patients were graded in this way. No retinopathy (photo. grade 1) was present in fifty one (left) and fifty (right) eyes, a total of one hundred and one eyes (53%). Background retinopathy (photo grades 1.5-5) was found in thirty six (left) and thirty seven (right) eyes, a total of seventy three eyes (38%).

Severe retinopathy, or eyes ungradable due to diabetic eye disease (photo grades 6-8) was found in nine (left) and eight (right) eyes, a total of seventeen eyes (9%).

Looking at the results in terms of the grading per individual patient then the following results were obtained (Table VI):-

- (1) The patients having no evidence of diabetic retinopathy in either eye ($n = 47$; 50%) had a mean age of 46 yrs (range 13-79) and the mean duration of diabetes

Table III Relevant details of attenders and non-attenders

PG=Photographed group

NPG=Non photographed group

	No.	Mean Age	Mean Age at Diagnosis	Mean Duration
Attenders	PG 96 NPG 17 } 113	50 47	33 29	17 18
Non- attenders	18	36*	25	11 * $p < 0.01$

was 10 yrs (range 0-29). The mean age at diagnosis of diabetes was 36 yrs (range 1-64)

- (2) Those with background retinopathy in one or both eyes (n=39) (41%) had a mean age of 51 years (range 21-81) and the mean duration of diabetes was 21 years (range 1-57). The mean age at diagnosis was 30 years (range 9-64).
- (3) Those with proliferative or advanced diabetic eye disease in one or both eyes (n=10; 9%) had a mean age of 52 years (range 26-71) and the mean duration of diabetes was 24 years (range 13-51). Mean age at diagnosis of diabetes in these patients was 28 years (range 9-50). One of this group was considered to have

untreated proliferative disease and referral for further assessment was recommended.

Photographic grades of Maculopathy

In addition to the overall grading of retinopathy the separate grading for the presence of maculopathy revealed the following results:-

- (1) seven patients (6.0%) had undergone focal photocoagulation to the macular region for presumed diabetic maculopathy. The mean age of this group was 57 years (range 41-66), the mean duration of diabetes was 20 years and mean age at onset of 37 years.
- (2) a further nine patients (8%) had untreated maculopathy and it was recommended they should be referred for evaluation. The mean age of this group was 53 years (range 22-67) the mean duration of diabetes of 17 years and the mean age at onset 36 years

Table IV Age-specific photographic grades of retinopathy

Age (yrs)	Retinopathy grades								
	1	1.5	2	3	4	6	6.1	6.5	8
0-19	10	-	-	-	-	-	-	-	-
20-39	32	1	5	8	1	-	2	1	-
40-59	29	-	7	13	4	-	4	-	-
60+	30	4	4	22	4	1	4	-	5
Total	101	5	16	43	9	1	10	1	5

Table V Retinopathy grades related to duration of diabetes

Duration Diabetes (yrs)	Retinopathy grades								
	1	1.5	2	3	4	6	6.1	6.5	8
0-9	55	-	2	5	5	-	-	-	-
10-19	28	1	5	14	2	-	2	-	1
20-29	12	3	6	19	2	-	6	-	1
30+	6	1	3	5	-	1	2	1	3
Total	101	5	16	43	9	1	10	1	5

Additional information

Photographic grades were not available in thirty five patients but the following information was obtained:-

- (1) of the seventeen seen but not graded photographically four were found clinically to have background retinopathy.
- (2) the practice records showed that one of the eighteen non-attenders was blind from advanced diabetic disease but no other ophthalmic problem was documented in this group.

Overall prevalence of retinal disease

By incorporating this additional information a total estimate of the prevalence of diabetic

Table VI Number of patients with Grade 1 (no retinopathy) Grades 1.5-5 (background retinopathy) and Grades 6-8 (proliferative or advanced retinopathy)

Retinopathy grade	No.	%	Mean age	Mean age at Diagnosis	Mean Duration
1	47	50	46	36	10
1.5-5	39	41	51	30	21
6-8	10	9	52	28	24

retinopathy in the 131 insulin-requiring diabetic patients may be obtained:-

- (1) No retinopathy 59%
- (2) background retinopathy 33%
- (3) significant or serious diabetic eye disease 8%
- (4) maculopathy 6.8%

Undetected, potentially treatable, retinal disease was found in 7.6%, one of the patients having proliferative disease and nine diabetic maculopathy.

Visual acuity

Two patients, aged 63 years and 77 years were blind and this represents 1.5% blind registration as the result of diabetic retinopathy. Four patients (3%) had acuities of less than 6/24 in either eye due to diabetic retinal disease and a further five (3.8%) only finger counting vision in one eye, three due to diabetic retinal disease and two due to cataract. Fifty eight patients (51%) had acuities of 6/6 or better in both eyes.

Risk factors

The potential risk factors examined are shown in Table VII. They were assessed for three broad categories of retinopathy, namely, no retinopathy, background retinopathy, proliferative and advanced disease. The most significant risk factor found for severity of retinopathy from these data was a longer duration of diabetes ($p < 0.0001$). Elevated diastolic blood pressure and higher age at examination also being shown to be significant ($p < 0.05$) (Table VIII). On further analysis, when it was assumed that duration of diabetes was known the most important additional risk factor was found to be elevated diastolic blood pressure (Table IX).

The same set of potential risk factors were evaluated for maculopathy. A higher age at the time of examination and at diagnosis ($p < 0.01$), and elevated systolic blood pressure ($p < 0.05$) were the three risk factors that were statistically significant (Table X).

Discussion

The patients studied in this survey were identified from a population in which the prevalence rate of diabetes was 10.9 per

Table VII

Factor	Risk factors considered		
	Units	Mean	Range
Systolic BP	mmHg	153	99-249
Diastolic BP	mmHg	83	52-103
Age	yrs	49	13-79
Age at Diagnosis	yrs	33	1-69
Duration	yrs	16	0-52
Glycosylated	%	8.9	4.1-17.3
Haemoglobin			

Table VIII Risk factors considered for retinopathy

Risk factor	Retinopathy I	
	Drop in deviance	p-value
Systolic BP	1.0	ns
Diastolic BP	6.4	$p < 0.05$
Age	6.4	$p < 0.05$
Age at Diagnosis	1.0	ns
Duration Diabetes	28.4	$0 < 0.0001$
Glycosylated	0.1	ns
Haemoglobin		

Table IX Risk factors considered for retinopathy assuming duration known

Risk factor	Retinopathy II	
	Drop in deviance	p-value
Systolic BP	0.5	ns
Diastolic BP	6.4	$p < 0.05$
Age	0.5	ns
Age at Diagnosis	0.5	ns
Glycosylated	0.2	ns
Haemoglobin		

Table X

Risk factor	Retinopathy II	
	Drop in deviance	p-value
Systolic BP	5.0	$p < 0.05$
Diastolic BP	2.4	ns
Age	9.9	$p < 0.01$
Age at diagnosis	8.6	$p < 0.01$
Duration	0.0	ns
Glycosylated	0.7	ns
Haemoglobin		

thousand, very similar to the United Kingdom prevalence of about 10 per thousand suggested by West.⁽⁹⁾ The response rate for the survey was 86%. The non-responders tended to be younger and included some students living away from home, and patients who felt that enough of their time was already being spent in the control of their disease. The practice records showed that all but one had no documented eye problems.

Direct comparisons between surveys of the ophthalmic problems of diabetic patients are not always possible. For example those surveyed in special hospital clinics are a pre-selected group, in some studies only specific age-groups have been examined and definitions for diabetes and grading of ocular findings vary. In addition the prevalence rate for diabetes varies in different cultures as do criteria for blind registration. Caird et al¹⁰ calculated from the figures of Sorsby¹¹ that about 2% of diabetics in England and Wales were blind from retinopathy. This is probably a minimum figure and would certainly underestimate the number handicapped by reduced vision but not eligible for blind registration. This is indicated by the fact that in this survey 1.5% were registered blind but an overall figure for visual disability of 8.3% was found.

The overall prevalence of diabetic retinopathy of any sort was 41% in this study, with 33% having background and 8% significant or severe disease. This is lower than that reported by Sjolie¹² in a study of a Danish population, when an overall occurrence of 77% for men and 74% for women was found. Nilsson¹³ found prevalence rates of 40% background and 15% proliferative retinopathy in another Danish population. The Wisconsin⁶ survey of those diagnosed diabetic before the age of 30 years found an overall prevalence rate of 71% with retinopathy in those with diabetes for less than five years and 97.5% in those diabetic for 15 years or more. Grey et al¹⁴ in a survey of an English diabetic clinic found retinopathy to be present in 43.4% of insulin dependent diabetics studied and sight threatening retinopathy in 13.3% of eyes of those studied.

That the prevalence and severity of retinopathy increases with duration of diabetes is well established^{15,16}, and the results of this survey are in accord with this finding. A small number of those diabetic for less than ten years had background retinopathy whilst those who had undergone pan-photocoagulation had a duration of at least ten or more years and severe disease was found predominantly in those with a duration of twenty or more years.

Elevated diastolic blood pressure was found to be an additional risk factor for retinopathy and a significant association between blood pressure and degree of retinopathy has been found in other studies.^{17,18} The Wisconsin study⁶ found higher diastolic blood pressure to be significantly related to the presence and severity of retinopathy in younger-onset insulin taking patients and systolic blood pressure in older onset diabetic patients. Although both hypertension and retinopathy may be the independent result of diabetic microvascular disease enough evidence seems to exist to suggest that good hypertensive control is a worthwhile aim in an attempt to limit retinopathy.

No significant association was found in this study between recent diabetic control, as measured by the level of glycosylated haemoglobin, and the prevalence and severity of retinopathy. However it would be incorrect to draw conclusions from this result as a single measure of the control over the weeks preceding examination in no way indicates the degree over the preceding years. Studies have shown that good diabetic control has a beneficial effect on retinopathy.¹ Bradley and Rames¹⁹ found that in juvenile diabetics followed for 20-40 years 7% with good control, 19% with fair control and 43% with poor control had marked or extreme retinopathy. Animal experiments have added weight to the general impression that good metabolic control is desirable with regard to retinopathy. In a trial with dogs Engerman²⁰ found that good diabetic control resulted in less retinopathy and that the response of the retinal vasculature was influenced by the previous degree of control.

Potentially treatable retinal disease was undetected in 7.6% of those studied and all but one of these had maculopathy. The prevalence of diabetic maculopathy was high in this insulin-requiring population in view of its traditional association with the non insulin-dependent type.²¹ A higher age at examination and at diagnosis were the two most significant risk factors and the mean age at examination of 53 years and age at diagnosis of 36 years shows that they belong to the older-onset group of diabetics. Duration of diabetes was not found to be a significant factor in the development of maculopathy but diabetes of the older-onset type is known to have a long pre-clinical phase and its precise duration difficult to define. In this survey no potentially treatable retinopathy was found in those having diabetes for less than ten years and examination within this time would be prudent for those with diabetes of the younger-onset type. However the older-onset type insulin-requiring patients may have significant disease at diagnosis and ophthalmic examinations should be carried out soon afterwards.

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