

The occurrence and causes of registered blindness in diabetes patients in Århus County, Denmark

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ABSTRACT.

Purpose: To report the occurrence of registered blindness among diabetes patients in Århus County, Denmark during 1993–2002.

Methods: Data were obtained from a database of 7527 diabetes patients, which included all patients in the county who had been treated for or had experienced visual loss due to diabetic retinopathy since 1992. Of these, 1949 had type 1 diabetes and represented 90% of the type 1 diabetes patient population in the county, and 5459 had type 2 diabetes and represented 40% of the type 2 diabetes patient population in the county.

Results: The point prevalence of legal blindness was 0.6% for type 1 and 1.5% for type 2 diabetes patients at January 1st, 2003. In type 1 diabetes patients, the major cause of blindness was proliferative diabetic retinopathy (PDR) (66.2% of all blind eyes); in type 2 diabetes patients the major causes were age-related macular degeneration (21.9%), PDR (18.0%) and diabetic maculopathy (DMac) (18.5%). During 1993–2002 there was a significant decrease in the number of blind eyes secondary to PDR ($p=0.008$) in type 1 diabetes patients, and a significant increase in the number of blind eyes secondary to DMac ($p=0.005$) in type 2 diabetes patients.

Conclusion: The major challenge in reducing diabetes-related blindness is related to the detection and treatment of an increased incidence of diabetic maculopathy in type 2 diabetes patients.

Key words: diabetic retinopathy – epidemiology – diabetes mellitus – blindness – diabetic maculopathy – proliferative diabetic retinopathy – social blindness – legal blindness

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Introduction

Diabetic retinopathy (DR) is a significant cause of visual impairment in the industrialized countries (Munier et al. 1998). It has been shown that increased focus on the prevention, detection,

diagnosis and timely treatment of DR can prevent a large majority of its vision-threatening consequences (Diabetic Retinopathy Study Research Group 1998; UK Prospective Diabetes

Study Group 1998; Epidemiology of Diabetes Interventions and Complications Research Group 2000). However, in many places this knowledge has been difficult to transfer to clinical practice, mainly due to organizational and institutional limitations. The key element in the handling of diabetic eye disease is the establishment of a systematic screening programme with database registration and quality control of clinical activities. This has been achieved in several Scandinavian centres, mainly related to university hospitals (Bek 1998; Lovestam-Adrian et al. 2001; Hansson-Lundblad et al. 2002). However, the progress made by these measures in reducing blindness secondary to DR and the remaining problems have been scarcely documented.

In Århus County, Denmark, a screening programme for DR was founded in 1992. A database was constructed, which has since accumulated screening data for nearly the total type 1 and approximately half the type 2 diabetes populations, as well as for all treatment for diabetic retinopathy and all reported cases of legal blindness in diabetes patients in this period.

This study reports the occurrence of blindness secondary to diabetic retinopathy and other eye diseases among diabetes patients in Århus County during 1993–2002. Causes of the observed patterns of visual impairment and blindness are discussed.

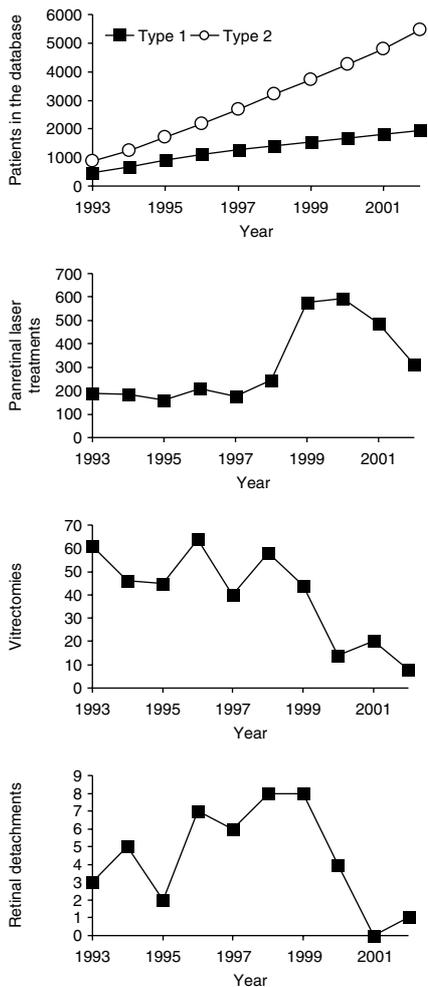


Fig. 1. The number of patients registered in the database during 1993–2002 and the number of treatments performed on diabetes patients at the department.

Methods

Data material

The Department of Ophthalmology, Århus University Hospital, is the centralized eye clinic in Århus County, Denmark, and receives all patients in the county for diagnosis (fundus photography, fluorescein angiography and optical coherence tomography) and treatment (photocoagulation, vitrectomy, neovascular glaucoma treatment, tractional retinal detachment surgery) for DR, and all patients with severe retinopathy leading to visual loss. The department also receives information about diabetes patients who become members of the Danish Society of Blindness and about patients who attend the county's low vision aid clinic. These data have been entered into a database for DR since 1992. The database also contains information

about all screening examinations for DR (visual acuity measurement and fundus photography) performed in the department during the same period (Bek 1998). The information used here on visual acuity was measured on charts (Wang & Pomerantzeff 1991), according to the principles outlined by the Guidelines from the Eye Care Technology Forum (Ferris & Bailey 1996). Fundus photographs were graded according to the principles used in the Wisconsin Epidemiologic Study of Diabetic Retinopathy (Klein et al. 1984a).

The patients were defined as having type 1 diabetes (age of onset less than 30 years and insulin required from onset) or type 2 diabetes (all other patients except those who had diabetes secondary to pancreatic disease or congenital syndromes). At the time of the data sampling (January 1st, 2003) the database contained information on 1949 type 1 diabetes patients, 5459 type 2 diabetes patients and 119 patients with other types or unknown types of diabetes in Århus County (total population 644 666). The remaining type 1 diabetes patients were mostly children who were not due to be systematically entered into the screening programme until puberty, whereas the remaining type 2 diabetes patients were those screened by private practice ophthalmologists or those who were apparently not being screened at all.

The number of patients in the database has increased every year due to the recycling of patients between the centralized screening clinic and private practice ophthalmologists, and because fatalities, migration and dropouts are not deleted from the database (Fig. 1). After each screening examination, the recommended interval to the next examination is noted in the database in order to monitor patients who drop out of the centralized screening programme. This monitoring allowed us to calculate the numbers of patients participating actively in the programme at the time of analysis (January 1st, 2003) to be 907 type 1 and 3209 type 2 diabetes patients.

A total of 702 patients (9.3%) among the 7527 in the database were identified as having unilateral or bilateral visual acuity (VA) of ≤ 0.1 (116 with type 1, 577 with type 2, and nine with unclassified diabetes type). Blindness was defined as blindness in one eye, whereas legal blindness was defined as VA of ≤ 0.1 in

the better eye. The mean age at the most recent examination was 36 ± 13 years for the type 1 population and 61 ± 13 years for the type 2 population.

Proliferative diabetic retinopathy (PDR) was classified as preretinal vessels originating from large veins and with a recurrent course back on themselves. Clinically significant macular oedema (CSMO) was defined as retinal oedema within half a disc diameter from the centre of the macula, or an area of more than one disc diameter of which a part was positioned within one disc diameter from the centre of the macula. If PDR and CSMO were present in the same eye, the cause of blindness was set as being CSMO unless blindness due to PDR had been registered before the occurrence of CSMO.

Simple linear regression analysis was used to study the relationship between time and the relevant parameters.

During 1993–2002, the number of eyes in diabetes patients in the county with newly diagnosed PDR increased significantly per year, from 21 to 53 for type 1 diabetes patients ($p = 0.03$), and from 34 to 48 for type 2 diabetes patients ($p = 0.04$). In the same period, the yearly number of newly diagnosed, clinically significant cases of macular oedema remained unchanged among type 1 diabetes patients ($p = 0.07$) but increased significantly among type 2 diabetes patients from 23 to 104 ($p = 0.003$).

Data analysis

The number of registered cases of blindness in the population participating actively in the screening programme at the time of data analysis was used to calculate the point prevalence of blindness at this time. The numbers of registered cases of blindness due to diabetic eye complications during 1993–2002 were calculated for type 1 and type 2 diabetes patients and the trends were analysed by simple linear regression of the data over the studied time period in order to test whether the slopes of the curves differed significantly from zero. All data were double-checked by the authors by reviewing the fundus photographs; in cases of doubt the treatment records of identified patients were also reviewed. Additionally, the age, type of diabetes and duration of diabetes of patients who had experienced visual loss were noted.

During 1993–2002 the population of Århus County increased from 609 890 to 644 666 inhabitants.

All statistical analyses were performed with Analyse-It™.

Results

The point prevalences of legal blindness among patients participating in the screening programme at the time of analysis was 0.6% (6/907) and 1.5% (48/3209) for type 1 and type 2 diabetes patients, respectively.

The causes of unilateral and legal blindness are shown in Table 1. In type 1 diabetes patients, the major cause of blindness was PDR (66.2% of all blind eyes), whereas diabetic maculopathy (DMac) accounted for only 4.0% of the blind eyes. In type 2 diabetes patients, the major causes of blindness were age-related macular degeneration (AMD) (21.9%), PDR (18.0%) and DMac (18.5%).

The numbers of eyes registered as blind due to PDR and DMac during 1993–2002 are shown in Fig. 2. In type 1 diabetes patients there was a significant decrease in the number of blind eyes secondary to PDR ($p=0.008$; $r^2=0.60$, $n=10$), but no change in the number of blind eyes due to DMac ($p=0.39$; $r^2=0.09$, $n=10$). In type 2 diabetes patients there was a significant increase in the number of blind eyes due

to DMac ($p=0.005$; $r^2=0.65$, $n=10$), but no change in the number of blind eyes due to PDR ($p=0.27$; $r^2=0.15$, $n=10$).

The time periods from diagnosis of diabetes mellitus to occurrence of blindness are shown in Figs. 3 and 4.

Discussion

This study is the first to report the occurrence of visual loss and its causes in a diabetes population over a period of 10 years during the implementation of a screening programme for DR. Epidemiological studies are unselected and therefore always include patients in whom the distinction between type 1 and type 2 diabetes is difficult to make. We therefore chose an operational criterion that makes data comparable with previously published epidemiological studies (Klein et al. 1984a, 1984b). The registration of visual loss in the population can be considered to be complete for type 1 diabetes patients, where only children and young persons with diabetes duration of less than 10 years were not registered in the database. Only approximately half of the type 2 diabetes patients in Århus County were registered at the time of the analysis. However, several factors argue that the registration of visual loss in type 2 diabetes patients is close to being complete. Firstly, all patients with visual loss are referred to the clinic to be evaluated for possible treatment of diabetic and other eye diseases. Secondly, no discrepancy was found between registration in the database and (independent) reporting of patients with VA of ≤ 0.1 in the better eye to the Danish Association of the Blind and the low vision aid clinic. Thirdly, a recent study from the same county has shown that the prevalence of visual loss due to diabetic retinopathy in an unselected population of type 2 diabetes patients not registered in the database is negligible (Hove et al. 2003).

The point prevalence of legal blindness among diabetes patients in the screening programme on January 1st, 2003 was similar to data published in reports from comparable centres (Kristinsson et al. 1994; Delcourt et al. 1995; Prasad et al. 2001; Fong et al. 2002;

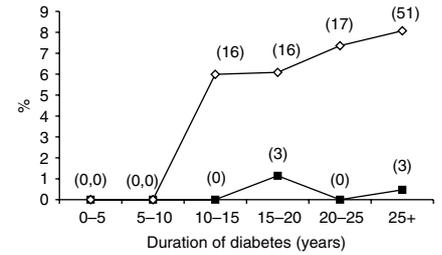


Fig. 3. The percentage of eyes of type 1 diabetes patients in the database developing blindness secondary to PDR (◇) and DMac (■) at different diabetes durations. Numbers in brackets indicate absolute numbers.

Hayward et al. 2002), and lower than figures reported in studies where screening activities were less intense (Sjolie 1985; Sjolie & Green 1987).

In type 1 diabetes the second most frequent cause of legal blindness concerned central nervous system (CNS) diseases (Friedreich's spinal ataxia, Wolframs syndrome, meningitis and optic nerve atrophy) Among type 2 diabetes patients legal blindness was due to diabetes in only 50% of cases, equally distributed between PDR and DMac. The remaining causes of legal blindness were age-related eye diseases, primarily AMD. These findings are in accordance with the reported relation between age and blindness in Denmark and elsewhere (Rosenberg & Klie 1996; Prasad et al. 2001), and with findings from both the general adult (Attebo et al. 1998; Hansson-Lundblad et al. 2002) and the ageing populations (Buch et al. 2001).

The medical care of DR includes prevention, detection, diagnosis and treatment of the disease, and all these measures are important for hindering visual loss. The observed decrease in the number of blind eyes due to PDR among type 1 diabetes patients was not related to the treatment pattern, which, as the only change, was standardized in 1999, but correlates well with the gradual increase in inclusion of the diabetes population in the screening programme. During the 10-year study period there was a significant increase in the number of patients with newly diagnosed PDR, suggesting that preventive measures such as better regulation of blood pressure and metabolism had not affected the incidence of eye complications. The success of the care measures (screening programme and treatment by photocoagulation) can be

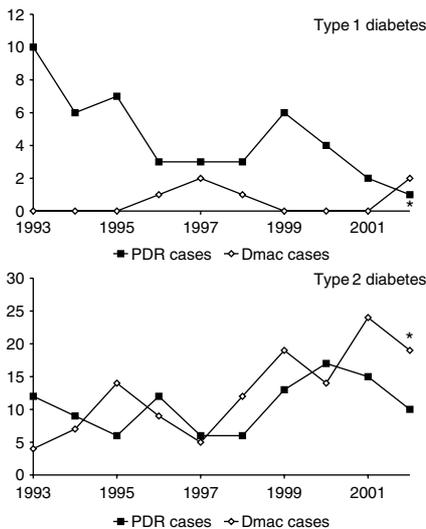


Fig. 2. The number of newly diagnosed blind eyes due to proliferative diabetic retinopathy (PDR) and diabetic maculopathy (DMac) for type 1 and type 2 diabetes patients during the period 1993–2002. * = significant change over the 10-year period ($p < 0.01$).

Table 1. Causes of blindness among diabetes patients registered in the database.

Causes	Unilateral blindness (%)		Legal blindness (%)	
	Type 1	Type 2	Type 1	Type 2
Diabetic				
Proliferative diabetic retinopathy	58.0	11.6	75.7	26.1
Diabetic maculopathy	2.5	12.8	5.7	25.8
Non-diabetic				
Amblyopia	12.3	15.7	0.0	0.6
Trauma	7.4	3.6	0.0	0.6
Vasculotrombotic diseases	3.7	9.9	0.0	0.9
Other retinal, choroidal and optic nerve diseases	3.7	3.4	0.0	2.8
Cataract and sequelae after cataract operation	2.5	9.4	2.9	7.7
Congenital diseases	2.5	0.2	0.0	0.0
Age-related macular degeneration, exudative	1.2	6.3	0.0	8.3
Corneal diseases	1.2	3.1	0.0	1.5
Central nervous system diseases	1.2	2.2	15.7	2.1
Chronic iridocyclitis	1.2	0.0	0.0	0.0
Age-related macular degeneration, non-exudative	0.0	13.8	0.0	16.0
Glaucoma	0.0	1.2	0.0	0.0
Other causes	0.0	1.0	0.0	2.5
Unknown	2.5	5.8	0.0	5.2
Sum	100	100	100	100
Number of eyes	81	414	70	326
Number of patients	81	414	35	163

seen from the fact that the frequency of blindness due to PDR has now reached the same low level as the frequency of blindness due to DMac. However, the increasing inclusion of the type 2 diabetes population in the screening programme has not been able to decrease the number of type 2 diabetes patients who experience visual loss due to DMac, probably because of the increasing incidence of type 2 diabetes and its accompanying complications in the general population (Burke et al. 1999; Kaufman 2002).

Similarly to previous studies, the time from onset of diabetes to onset of

blindness was found to differ between type 1 and type 2 diabetes patients (Nielsen 1982). Thus, in type 1 diabetes patients the event of blindness due to either PDR or DMac was seen to occur after 10 years of diabetes duration and increased sharply after 20 years of duration for PDR. In type 2 diabetes patients the event of blindness due to either PDR or DMac was already notable at the time of diagnosis and rose with increasing duration of diabetes, thus confirming previously reported findings (Klein et al. 1984b; Zander et al. 2000; Younis et al. 2002). This emphasizes the profound effects on diabetes-related blindness that may be the result of the evolving epidemic of type 2 diabetes.

In conclusion, the study shows that during the implementation of our screening programme there has been a decrease in the number of blind eyes due to PDR in type 1 diabetes patients. The results for type 2 diabetes patients are not similarly convincing, probably due to the increasing incidence of type 2 diabetes and its complications and the fact that the screening programme only covers half of this population. This is especially relevant because visual loss may be present at the time of diagnosis

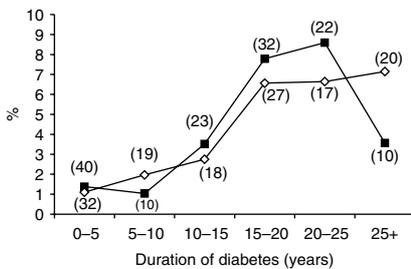


Fig. 4. The percentage of eyes of type 2 diabetes patients in the database developing blindness secondary to PDR (◇) and DMac (■) at different diabetes durations. Numbers in brackets indicate absolute numbers.

of diabetes mellitus, and the treatment modalities available for DR cannot fully prevent visual loss at this stage. Finally, a vast majority of the visual loss in type 2 diabetes patients is due to causes other than DR. This foreshadows additional problems in the prevention of blindness in the growing population of type 2 diabetes patients.

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