Macular recovery function (nyctometry) in diabetics without and with early retinopathy

E Midena, T Segato, M Giuliano, M Zucchetto

Abstract

Nyctometry was used to assess macular recovery function in 234 diabetic patients; their retinopathy ranged from no retinopathy (99) to early background retinopathy (135). None had visual symptoms or macular oedema. Abnormal (reduced) nyctometry findings were significantly and directly related to the deterioration of diabetic retinopathy. There was no significant association between reduced or normal nyctometry findings and glycaemia at the time of the examination. The value of nyctometry in screening and follow-up is discussed.

Diabetic retinopathy is considered to be a disease affecting either retinal blood vessels or neurosensory retina. The neurosensory alterations are caused in part by vascular alterations, but they also, and perhaps primarily, reflect the local and systemic metabolic derangements due to diabetes. The retinal neurosensory losses may predict the evolution of retinopathy toward more advanced forms and sometimes may preclude the onset of clinically detectable retinopathy. Such tests therefore seem to be useful not only for predicting the evolution of established diabetic retinopathy, but also for monitoring the retinal state of diabetic patients, when better control or new drugs are given to prevent the appearance of clinical retinopathy. The neurosensory losses involve macular recovery function among others.

The present study was undertaken to examine in more detail the relationship between modifications of macular recovery function, evaluated by means of nyctometry, and the retinal situation in diabetics without or with early diabetic retinopathy.

Patients and methods

The patients consisted of 234 diabetics seen at the Retinal Vascular Clinic, Institute of Ophthalmology, the University of Padova. The mean duration of diabetes was 13 years (SD 7). All patients had a visual acuity of 1-0 (equivalent to 6/6). Their retinopathy ranged from no retinopathy (99 subjects) to early background retinopathy. The retina was examined by direct and indirect ophthalmoscopy and fundus biomicroscopy. Fluorescein angiography was performed in diabetics clinically classified without retinopathy; it was negative in all these subjects. The patients with retinopathy were divided into two groups; I, with some microaneurysms and some retinal haemorrhages, but total haemorrhages less than stage 2 of photograph 2A of the Early Treatment Diabetic Retinopathy Study (ETDRS) protocol (83 subjects); II, with group I lesions and some hard exudates, less than standard photograph 3 of the ETDRS protocol, all located outside the macular zone (52 patients). No patient had soft exudates, intraretinal microvascular abnormalities, or signs of macular oedema, nor had any patient previously received photocoagulation. No cardiovascular, neurological, or other ocular disease was present at the time of the examination. Among these diabetics 134 randomly selected subjects underwent blood sugar determination (Reflocheck, Boehringer, Mannheim, FRG) immediately after the macular recovery function had been studied.

The patient looks into a white coloured globe, in which a sight test chart is placed opposite to the patient’s eye. The test chart is composed of 10 lines (visual acuity from 0-1 to 0-0) of numbers, which can be modified to prevent memorisation. The optical system of the instrument is made to determine long distance visual acuity.

Briefly, nyctometry consists of three steps. The first is a 3-minute adaptation to strong light (7000 asb; 2200 cd/m²). The light is then switched off and the 2-minute initial phase of dark adaptation begins. During this phase the patient has to record the test signs (illumination 0-5 asb; 0-16 cd/m²); thus we record the increase in visual acuity as a function of time. The last step is a measure of patient’s sensitivity to glare (for details of technique see Frost-Larsen et al). The last two phases are graphically recorded on a form. The individual graph is compared with standard age-related ranges of normality (20–30, 31–50, 51–60, 61–70 years). The result is reported as reduced or normal. Reduced nyctometry means a value below the 2-5 percentile of the normal age-related range.

The statistical analysis was by the $\chi^2$ test. When the results in the two eyes were similar, data from the right eye are reported. In addition the results of nyctometry were quantified by the summation method proposed by Frost-Larsen and Larsen. This method, called by the proposers ‘intensified calculation of macular recovery time’, gives an absolute number for
Nyctometry

6-7 22

TABLE II

summation method
normal and diabetic

697-0(217-8)
31-SOyr
yr

blood glucose quantified subjects (6677%)
6-8-8-9 (mmoll)

538(301-2)
388-2(301-2)
389-0(308-0)
197-5(171-7)

Total 234

p=0.002.

each examination. This number results from the
sum of the products of ten times each reached
step of visual acuity (0-1 = 1, 0-2 = 2 ... ) and the
difference between 120 seconds (the whole 2-
minute course of cone adaptation) and the actual
time (in seconds) taken to reach that step.

Results

In a preliminary phase we performed nyctometry
in a large population of normal subjects of
different ages (20 to 70 years). Their macular
recovery function always lay in the normal age
related range given by the manufacturer of the
instrument (Midena et al, unpublished data).

Table I summarises the results of nyctometry
evaluation in our diabetic population. The
proportion of abnormal (reduced) results increased
with deterioration of the retinopathy: 45-8% in
group I, 67-3% in group II. Moreover we observe
that 37-4% of the patients classified (clinically
and angiographically) without retinopathy
showed altered macular recovery function. The
nyctometry results were significantly related
(χ²=12-34, df=2, p=0.002) to the progression of
subclinical and clinical diabetic retinopathy.

The blood glucose level at the time of nycto-
metry determination did not influence the result
of the examination (Table II). The quantitative
data of nyctometry (Table III) showed a decrease
of this function with age in normal and diabetic
subjects.

Moreover it showed in each age group a
worsening of macular recovery function with
deterioration of the retinopathy.

Discussion

Nyctometry is a standardised technique used to

<table>
<thead>
<tr>
<th>TABLE I</th>
<th>Nyctometry determinations compared with retinal state of diabetic patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nyctometry</td>
<td>No retinopathy</td>
</tr>
<tr>
<td>Reduced</td>
<td>37 (37-4%)</td>
</tr>
<tr>
<td>Normal</td>
<td>62 (62-6%)</td>
</tr>
<tr>
<td>Total</td>
<td>99</td>
</tr>
</tbody>
</table>

p=0.002.

measure macular recovery function in a short
time. The test lasts 6-5 minutes only. The result
is easily compared with standard age related
curves. The normal data from our laboratory
appeared to be identical to those given by the
manufacturer; we therefore use the age ranges
provided by the manufacturer. In consequence
the result is independent of the patient’s age.
This is a great advantage in respect of other
functional methods, where normative age related
data are not available. Some authors consider
nyctometry to be a technique for measuring dark
adaptation – more precisely, the dark adaptation
of the cone system.9 Nyctometry quantifies not
only the dark adaptation of the cone system but
also the macular sensitivity to glare. We there-
fore think it is entirely adequate for studying the
function of the macula.

Previous reports on nyctometry have sug-
gested that it can be used to predict the pro-
gression of background retinopathy to the
proliferative form.24 Similar results have been reported
with the electrotetrogram oscillatory potentials.2

In contrast very few reports have dealt with
the use of nyctometry in diabetics without or
with early retinopathy. Gliem and Schultz11
showed that 42 of 159 eyes of diabetics without
retinopathy gave abnormal nyctometry results.
But their study suffers from some methodologi-
acuracies: they did not use age related
normal ranges; the results of nyctometry were
related to nyctometry without considering the
age of the patient. Frost-Larsen and Larsen12
reported that two out of 57 eyes of diabetics
without retinopathy gave reduced nyctometry
results, but their paper does not consider this
problem in detail.

Our data clearly show, in a well defined series
of patients, that reduced nyctometry is directly
and strongly related to the progression of retinal
(functional and anatomical) derangements due to
diabetes. This is confirmed by a quantitative
method. The limit of this and the other methods
proposed to quantify nyctometry is the inade-
quacy of each to describe adequately the curve
obtained with this test. The final visual acuity
and the Frost-Larsen and Larsen summation
method show too great a variation in results.11

The area under the curve – proposed by
Brinchmann-Hansen et al12 – gives equal results
with different curves.

We therefore consider that so far the best way
to classify nyctometry results is qualitatively
(normal, reduced). Our data are similar to
those obtained by means of other functional
tests.13-16

Moreover the results of nyctometry are
independent of the glycaemic status of a patient
who is healthy at the time of the investigation.
No comparable data are available from previous
studies performed with other functional tests in
diabetics. We have also shown that 37-4% of
subjects considered by current standards to be
unaffected by retinopathy give reduced nycto-
metry results, an indication of abnormal macular
function. At present we do not know why
macular recovery function is abnormal in these
subjects. They may perhaps represent, among
diabetics without retinopathy, a group in whom

<table>
<thead>
<tr>
<th>TABLE II</th>
<th>Blood glucose level at the time of nyctometry examination in 134 randomly selected diabetics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glycerina (mmol/l)</td>
<td>6-7</td>
</tr>
<tr>
<td>Reduced</td>
<td>11 (33-3%)</td>
</tr>
<tr>
<td>Normal</td>
<td>22 (66-7%)</td>
</tr>
<tr>
<td>Total</td>
<td>33</td>
</tr>
</tbody>
</table>

p=0.0065.

<table>
<thead>
<tr>
<th>TABLE III</th>
<th>Nyctometry quantified by the summation method (Frost-Larsen and Larsen'). In normal and diabetic subjects the absolute value of nyctometry has been calculated by the summation method (see text) and the mean of each age group is reported (standard deviation in brackets)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age group</td>
<td>Normals</td>
</tr>
<tr>
<td></td>
<td>No retinopathy</td>
</tr>
<tr>
<td>10-30 yr</td>
<td>712-5 (306-8)</td>
</tr>
<tr>
<td>31-50 yr</td>
<td>697-0 (217-8)</td>
</tr>
<tr>
<td>51-60 yr</td>
<td>692-2 (200-8)</td>
</tr>
<tr>
<td>61-70 yr</td>
<td>262-3 (123-9)</td>
</tr>
</tbody>
</table>
retinopathy will soon appear. A similar hypothesis has been proposed by Della Sala et al11 using a contrast sensitivity test. To confirm (or not) this hypothesis a five-year prospective study is in progress.

Our data also suggest that nyctometry might be used as a simple, quick, and non-invasive test to monitor the function of the macula in diabetics during intensified metabolic control or drug treatment. A further implication of our results on nyctometry in diabetic patients should also be pointed out. The site of the initial stage of dark adaptation is not yet completely defined, but it is thought to involve neural processes in the retina.10-16 Nyctometry is thus a test which provides information about the function of a specific part not only of the visual system but also of the retina. This could provide new insight into the pathophysiology of diabetic retinopathy.

1 Bresnick GH. Diabetic retinopathy viewed as a neurosensory disorder. Arch Ophthalmal 1986; 104: 989–90.

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