ABSTRACT

Objective: To assess if diabetes, in patients without cataracts or diabetic retinopathy, alters the densitometric values of the lens and to what degree this occurs.

Methods: A total of 93 patients, divided into two groups, were studied: the diabetic patients had a visual acuity equal to or greater than 0.8 and normal eye funduscopy, and the control group consisted of healthy patients of a similar age. Measurements in all patients were made with the Scheimpflug camera and the lens density of the anterior capsule, anterior cortex and nucleus was defined. The values obtained in the two groups were compared by analysis of variance (ANOVA).

Results: All densitometric values were greater in the diabetic patients than in the normal controls. The greatest difference was seen in the values of the anterior capsule, followed by the nucleus and cortex. The differences approached statistical significance (P=0.07) only in the case of the anterior capsule.

Conclusions: Diabetes increases densitometric values of the anterior capsule and to a lesser degree...
of the anterior cortex. However, further studies are necessary to verify if this alteration is of significance (Arch Soc Esp Oftalmol 2007; 82: 141-146).

**Key words:** Diabetes, Lens, Scheimpflug, cataract, densitometry.

**INTRODUCTION**

Diabetes affects practically all the ocular structures and the lens is one of the most altered structures along with the retina. The changes which have been documented includes osmotic, refractory, and accommodative changes and an increased risk of having cataracts, either the typically diabetic «snow ball» cataract which appears in young people and usually evolves rapidly, or due to an increased and early frequency of appearance of senile cataracts (1). Other more precise techniques, such as fluorophotometry, have also found subclinical differences in the lens of diabetic patients compared with the general population.

Scheimpflug’s camera is a noninvasive diagnostic system designed for analyzing the anterior segment of the eye (2,3). The obtained images are based on a measurement system which uses blue light (free of UV) which impinges on the eye in slit form, a camera that gathers images and a computerized analysis system (50 images with 25,000 points of elevation generated in less than 2 seconds). The rotatory process of measurement shows in 3-D the anterior segment of the eye and allows to measure the density of the lens in anyone of its points in the three spatial dimensions (fig. 1).

Our intention is to study the lens by means of Scheimpflug’s camera in two samples of subjects: control population and diabetics with good visual acuity without retinopathy. We wished to find out if diabetes without apparent ophthalmological repercussion causes an early alteration of the densitometric values of the lens and to what extent this takes place.

**SUBJECTS, MATERIAL AND METHODS**

**Selection and groups of patients**

We studied 93 eyes belonging to 47 subjects who were divided in two groups:

1) 53 eyes belonging to 27 patients with diabetes type II. All of them were in pharmacological treatment for diabetes Their average age is of 57.8 and the SD (standard deviation) of 9.5 years.

2) 22 eyes belonging to control subjects without ophthalmological or systemic pathology worthy of note. The average age is of 55.8 and the SD of 8 years.

All the subjects had a visual acuity equal or superior to 0.8, measured with Snellen optotypes. The patients having refractive defects above 5 spherical diopters or three cylindrical diopters were discarded. At the time of the exploration the subjects did not exhibit visible opacities in the lens or any other type of ophthalmological pathology, including normal eye fundus.

**Conclusiones:** La diabetes incrementa los valores densitométricos de la cápsula anterior y en menor medida del cortex anterior. No obstante son necesarios nuevos estudios para verificar si esta alteración se produce de forma significativa.

**Palabras clave:** Diabetes, cristalino, Scheimpflug, cataratas, densitometría.

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*Fig. 1: Photography of the anterior segment by means of Scheimpflug’s camera. To the right, in green, a 2-D representation of the densitometry of the cornea and anterior chamber through a predetermined axial axis. In this case, the rounded cortical opacities correspond to a budding diabetic cataract snowball form, shown as an example of the sensitivity of the technique, although the patient was not included in the study for not fulfilling the inclusion criteria.*
Lens densitometry study

All patients were measured with Scheimpflug’s camera (Pentacam Scheimpflug imaging system, Oculus) indicating the lens density of the anterior capsule, the anterior cortex anterior and the nucleus.

Statistical study

The comparison between the two samples is made by means of variance analysis (ANOVA). In order to avoid a bias, the average values obtained in both eyes of each patient were recorded.

RESULTS

The obtained results are in table I. All the densitometric values were greater in the diabetic patients than in the normal ones. The biggest difference occurred in the values of the anterior capsule, followed by the nucleus and cortex. Only in the case of the anterior capsule the values were close to statistical significance (P=0.07). Statistically significant differences between the ages of both samples did not occur (P=0.57).

DISCUSSION

There are numerous clinical tests which confirm that diabetes mellitus affects the lens. Osmotic changes are usually invoked as the cause of transitory variations of refractive errors due to the high hydration of the lens which makes it particularly sensitive to variations in its composition (4,5). Glucose, which is high primarily in serum, begins to spread producing a subsequent elevation in aqueous humor. Thence it penetrates the lens by diffusion and produces a change in its osmolarity and consequently in its refractive index. Besides, the hydration changes produce a modification of the lens curvature, changing its focusing power. This effect can so be acute that the patient notices the refracting changes in the form of cyclical defocusing at different times of the day. In addition to refractive changes, there are other changes in accommodation, perhaps induced by the hydration of the lens capsule. In some patients glycogen deposits have been observed in the ciliar body, which could be the cause of the precocious presbytia observed in some diabetic patients.

The excess of glucose in the lens of diabetic patients produces glycosilation of proteins, a part of which is reduced to sorbitol by means of the aldose enzyme reductase pathway. The accumulation of sorbitol produces a greater osmotic change, alterations in the permeability and finally formation of cataracts (6,7). The early existence of cataracts is well known in diabetic patients (1). There are juvenile cataracts in «snowflakes» form, which progresses quickly and is quite rare to find, and another, senile, typically nuclear cataract. The Health and Nutrition Examination Survey and the Framingham Eye Study found a significantly increased prevalence (in a factor of three) in diabetic patients with respect to the normal population over forty years.

It is difficult to detect lens alterations which do not produce a reduction of visual acuity or which do not produce visible opacities. The most sensitive techniques for studying the live lens include nuclear magnetic resonance with phosphorus (which determines the intralens levels of metabolites such as ATP, glycerol, sweetened phosphates and water), the measure of their fluorescent components (fluorophores), which can be detected with spectroscopy, Raman laser or fluorophotometry and Scheimplug’s camera (which measures the optical density of its different parts).

Scheimplug’s camera takes up to 50 images with 25,000 points of elevation generated in less than 2 seconds (2,3). A second camera controls the fixa-

Table I. Average and standard deviations for densitometry of various lens areas in normal and diabetic patients

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Diabetics</th>
<th>Control group</th>
<th>SS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior Capsule Densitometry</td>
<td>15.15 SD 4.4</td>
<td>12.91 SD 3.71</td>
<td>p=0.07</td>
</tr>
<tr>
<td>Cortex Anterior Densitometry</td>
<td>20.46 SD 5.29</td>
<td>20.18 SD 5.05</td>
<td>p=0.94</td>
</tr>
<tr>
<td>Densitometría núcleo</td>
<td>12.11 SD 3.05</td>
<td>10.96 SD 2</td>
<td>p=0.15</td>
</tr>
</tbody>
</table>

SS: statistical significance between the samples; SD: standard deviation (see commentary in the text).
tion and corrects any possible eye movement. From the obtained images the control unit calculates a model of the anterior segment in three dimensions (fig 1). This system allows to measure the thickness of the cornea and the lens, the pupil size, the densitometry of the lens and cornea and the morphologic study of the anterior segment. Clinical applications at lens level refer to the quantitative evaluation of density as well as to the study of diverse aspects related to surgery (8-11).

Evidence of non-cataract lens in diabetics is not abundant. Fluorophotometry allows to measure the intensity of the autofluorescent substances and their transparency or transmittance (12,13). By means of this system, a subclinical increase of the autofluorescence and transmittance of the lens has been demonstrated (14-21). Ultrasonography has also been used with the same purpose (22). By means of Scheimpflug’s camera, Kato found in 30 diabetic eyes a significant increase of the lens opacity with respect to the normal population which, in addition, is related to hyperglycemia in the long term (23). By means of microscopy and Scheimpflug’s camera, Tkachov found that the lens epithelium is damaged primarily in diabetic patients type II who develop cataracts (24).

The results of our study show an increase of lens densitometric values with respect to the normal population, which in no case was associated with clinical evidence of opacities in the lens. Both samples had ages that did not show statistical differences with regard to each other, and for this reason this variable does not seem to be decisive. Diabetes increases the densitometric values of the anterior capsule and of the anterior cortex, which coincides with the work of Tkachov that locates the initial damage of diabetes on the epithelium of the lens capsule and with the possible relation of capsular abnormalities with the accommodation alterations observed in diabetic patients. However, new studies are necessary to verify that this alteration occurs in significant values.

REFERENCES