Teleophthalmology as screening method for diabetic retinopathy

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Abstract
The aim of this study was to evaluate the suitability of teleophthalmology as a method for screening of diabetic retinopathy. It was designed as a transversal and observational study using the retinal fundus images of 520 patients that were studied during the first six months of 2006. This sample comes from a group of patients that are integrated in the Program of digital retinal screening. This screening program was established by the Integral Plan of Diabetes in Andalusia in 2005. It was evaluated the quality of images, the pick-up rate of the illness, the accuracy and the efficiency of the method. In 90% of the patients, the images possessed quality to be evaluated. The pick-up rate of the illness was 2.1. Agreement between existence or absence of diabetic retinopathy was analyzed by using unweighted kappa and its results equal 1. In conclusion, the results obtained in the study provide evidence for the reliability of telemedicine as a screening method for diabetic retinopathy.

Keywords: diabetic retinopathy, screening, teleophthalmology, technology, digital image.

Introduction
Diabetic retinopathy (DR) is a microangiopathy complication of diabetes mellitus (DM) with high social, medical and economical impact, being the second cause of blindness in Spain and the first cause on blindness during labor life.¹,² DR is a disease that fulfils the criteria for screening, since it is asymptomatic during initial stages of the process and an effective treatment to halt progression of the disease is available.¹,³ Screening of DR is accomplished by fundus examination, and the gold standard for the procedure are stereoscopic retinographies of 7 fields and 30 degrees (14 pictures) and ophthalmoscopy with contact and non contact lenses. Fundus examination should be performed at least once a year.³ However, data collected in United States indicate that 50% of diabetic population do not undergo periodical examinations and 60% of patients that need laser therapy do not receive it.⁴ Therefore, attendance to eye clinics seems not to be a suitable approach for DR screening. Further problems should also be considered, such as the time required for examination (35-40 min) and the need for eye doctor to perform the examination. These features, and the need to carry out the examination on a yearly basis,¹ determine that screening of DR with these techniques cannot be performed by an average eye unit.³,⁵

The above referred situation and the perspectives for a 72% increase in the prevalence of DM for the year 2026 with regard to the year 2003, has aroused the search for alternative screening methods.⁷ Among the options currently available, teleophthalmology represents a first choice alternative to the traditional methods for DR diagnosis.²,⁴ Screening by teleophthalmology is accomplished by visualization at the computer screen of retinography taken at distance in time and space. This option displays a set of features that makes it suitable for screening in a public health system: first, it reaches required standards of sensibility and specificity.²,⁶ Second, the time needed for evaluation of images is 5 minutes on average and third, it allows to store files of images that can be transferred in a minimal time. The Integral Plan for Diabetes in Andalusia aims at decreasing morbidity and mortality related to this disease and one of the programs addresses the improvement of the approach to chronic complications such as DR. Among the lines of action established to decrease the number of blindness caused by
diabetes, the early detection in order to get a diagnosis in stages that respond to treatment. Consequently, teleophthalmology was established as screening method.

The aim of our study is to evaluate teleophthalmology as a screening procedure for DR by means of the data collected over the first 6 months of the program in 2006.

**Methods**

In this survey, 1,734 type 2 diabetic patients with no previous history of DR entered the screening program summarized in figure 1. Patient selection is carried out by PCPs and nurse personnel. Retinographs from 3 retinal fields for each eye are carried out by nurse personnel at the PC centre. In case of poor quality of images, a drop of tropicamide is instilled and the procedure is repeated. First screen of images is performed by PCP at the PC centre. Images considered containing signs compatible with DR or any other retinopathy are sent to the ophthalmology service of the reference hospital. Poor quality images and images arousing doubts to the PCP were also sent to the reference ophthalmology service. In this second screen, patients with no DR are filtered again and decision is made concerning the need to be studied in the clinic.

Digital images were obtained in 11 Health Centres at the north district of the province of Seville with a non-mydriatic fundoscopic camera (Topcon, TCR NW-100). Images were stored in JPEG files 140 kb size on average. Images are sent to a central server and then sent to San Lazaro reference’s hospital. Telematic process is by the intranet of the sanitary network of Andalusia. The quality of the images received at the reference hospital was evaluated. Criteria to classify images as non-evaluable were blurred temporary arcades and/or more than 1/3 of the image field with no sharpness (with the exception of DR signs in the sharp areas of the image). Prevalence, stage according to 2003 Global Diabetic Retinopathy Project Group and detection rate of DR was also studied. In order to determine the exactitude and the degree of self concordance for DR diagnosis between the certainty method and teleophthalmology, comparisons between the results obtained by the same ophthalmologist were made with *kappa* statistics. Clinical examination of the retina with indirect ophthalmoscope and biomicroscopy of central retina with 78 dioptres lens were used as certainty method.
Results

The age of the patients was 67.4±10 years, and 64.7 were female. Ninety percent of the images transferred from PC were of enough quality to be evaluated. The prevalence of DR was 38%. From this percentage, it was inferred that the rate of detection of the disease or pick-up rate was 2.1 (Figure 2).

Figure 3 shows the distribution according to the gravity of DR. About 70.9% of 520 patients whose images were derived displayed lesions of mild grade, 19.3% showed lesions of moderate grade and 3.2% showed lesions of severe grade. In addition, macular edema was detected in 19.9% of diagnosed patients.

With respect to the 52% of patients whose images were no considered compatible with the diagnosis of DR (Figure 2) both non pathological and pathological signs were detected. Non pathological findings were drusen (21.7%) and chorioretinal atrophy (8.1%). Both findings constitute the principal cause of doubts and wrong diagnosis by PCP. On the other hand, among pathological findings, wet age-related macular degeneration was detected in 4% of cases and vein occlusion in 2% of cases. Statistical comparison performed with *kappa statistics* to determine the exactitude and the degree of interpersonal concordance in the diagnosis of DR by means of the certainty method and the teleophthalmology method, gave a result of 1. That is, a complete agreement was evidenced.

Figure 4 shows that 1,750 patients were evaluated by teleophthalmology. Seventy percent (1,230 patients) were cleared. The remaining 30% showed suspected images that were sent to the eye doctor. Twelve percent were cleared by the eye doctor and 17% (307 out 1,750) required direct examination in office for having images compatible with retinopathy (diabetic or not) or for having poor quality images.

Discussion

The aim of our study was to evaluate the suitability of teleophthalmology as screening method for DR. Results speaks in favour of this method for several reasons: first, the fact that only 10% of the images did not have enough quality to be informed leads us to infer that the diabetic population can be screened with this method. Second, the degree of interpersonal concordance in diagnosis of DR (*kappa*= 1) proves that digital imaging of the fundus obtained by fun-
Endoscopic camera and transmitted by internet is valid to perform a correct diagnosis of DR. Both conclusions agree well with the results reported in other studies.²,⁵

Finally, if we consider the percentage of patients filtered by PCP (70%) and the percentage filtered by ophthalmologists (42% of patients transferred from PC, figure 4), one can conclude that this method results in a substantial decrease in the workload that the program generates to the ophthalmology service. In addition, the implementation of the program has allowed a faster access to supplementary tests and treatments in patients that need it. In term of economics, according to the fares published in BOJA, the cost of PC office is 52 € and the cost of ophthalmology office is 145 €. It is clear that screening of patients at the PC results in a substantial saving. Teleophthalmology seems to be a reliable, effective and efficient method that can be applied to diabetic population.

In summary, although this method presents some limitations such as the detection of macular edema² and will no replace direct ophthalmologic examination, it features qualities that make it the most suitable method for DR screening in health public systems.

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Potential conflicts of interest
The authors are not aware of any conflicts of interest related to the subject of the review.

References