Original article

Diabetic retinopathy screening and teleophthalmology

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A B S T R A C T

Objective: To determine the prevalence of diabetic retinopathy (DR) and evaluate our experience in DR screening in a study carried out between the Ophthalmology Department of the University General Hospital of Alicante and Department 19 Primary Care of Alicante by using a non-retinal mydriatic camera and telemedicine.

Material and methods: A descriptive, cross-sectional study was conducted on 2435 diabetic patients from 1 February 2006 to 1 February 2009. Three 45° retinographies of both eyes of each patient were obtained and sent to the Department of Ophthalmology via the hospital intranet. These were then evaluated by 2 ophthalmologists, experts in the retina, with each issuing an individualized report for each patient.

Results: The prevalence of DR was 17.90%, with 80.73% of them having mild-moderate proliferative DR, 12.16% severe non-proliferative DR, 2.29% proliferative DR, and 4.82% with diabetic maculopathy associated with any level of retinopathy. The retinographies were considered low quality in 41 patients (1.69%).

Conclusions: We highlight the benefits of tele-ophthalmology in screening diabetic patients to enable early diagnosis and treatment, and improving the circuit of communication between primary and specialist care.

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Cribado de retinopatía diabética y teleoftalmología

R E S U M E N

Objetivo: Conocer la prevalencia de retinopatía diabética (RD) y evaluar nuestra experiencia en cribado RD en un estudio llevado a cabo entre el Servicio de Oftalmología del Hospital General Universitario de Alicante y el Departamento 19 de Atención Primaria de Alicante mediante la utilización de retinografías con cámara no mi átrica y telemedicina.

Métodos: Estudio descriptivo transversal de 2.435 pacientes diabéticos desde el 1 de febrero de 2006 hasta el 1 de febrero de 2009, obteniéndose tres retinografías de 45° en ambos
Introduction

The World Health Organization estimates that the diabetic population of the world exceeds 180 million patients and that this number is likely to more than double by 2030.1 A primary objective of the St. Vincent declaration was to achieve a significant reduction of blindness due to this disease.2

Diabetic retinopathy (DR) is the main cause of blindness in the working age population of developed countries.3 Approximately 2% of diabetic patients will be blind after 15 years and 8% will exhibit some degree of diabetic retinopathy.1-3

Detecting and treating DR in the initial stages can prevent blindness in diabetic patients, as proved by the Diabetic Retinopathy Study (DRS) and Early Treatment Diabetic Retinopathy Study (ETDRS).4,5

International diabetes screening guides have been established in order to detect DR in early stages before visual acuity is diminished. In diabetes type I patients, the first ophthalmological assessment must be performed 5 years after diagnostic, with subsequent annual assessments, while in diabetes type II patients the first assessment must be made at diagnostic time followed by annual assessments.6

Telemedicine can be applicable for diagnosing DR as a valid method according to published articles.3,7 The utilization of tele-ophthalmology, obtaining digital retinal images with a non-mydriatic camera, is an efficient alternative for early diagnostic and treatment of diabetic patients,7 reducing cost and inconveniences for patients.7-15 In addition, tele-ophthalmology involves the benefit of providing healthcare to a high number of patients while reducing waiting periods.16,17

This paper describes our tele-ophthalmology experience with 2435 diabetic patients, analyzing the results and advantages of said technique.

Material and methods

A transversal descriptive study of 2435 diabetic patients aged 18 or over and diagnosed with diabetes in our health area from February one, 2006 up to September 30, 2008.

The population covered by the Alicante General University Hospital is of 262,572 within Department 19 of the Community of Valencia.

The subjects of the study were 56.46% males (1375) and 43.54% females (1060), with ages comprised between 25 and 88 years, with a mean age of 62 years.

In what concerns the type of diabetes, 97.58% (2376 patients) had diabetes type I and 2.42% (59 patients) had diabetes type II.

The digital images were captured in a Health Center of Alicante Area (Spain) with a non-mydriatic retinograph (Topcon TRC-NW 100) by a nurse who had been trained for that purpose.

Three 45° images were obtained of each eye, comprising the macula, the nasal retina and papilla and the superior and inferior temporal retina. The retinographs were taken without previous miadriasis except in 127 patients (5.22%) with difficulties for obtaining the image, using one drop of Tropicamide (1 ml/10 mg Tropicamide, Alcon Cusi Laboratory), which improved the obtained images of 86 patients (3.53%) and enabled their assessment. In 41 patients (1.69%) the obtained images did not have enough quality for being assessed and were referred to the Specialty Center.

The software (Imagenet i-Base) (Topcon) manages the execution of the obtained retinographies, ensures the capture and transmission of images and also allows the transmission of patient clinical record (age, type of diabetes, evolution time, AHT history, treatments type, etc.). The program develops packs with patient data and images which are sent to the secure hospital intranet, accessible only to authorized staff. Restrictions were established on the use of information so that it could only be accessible to the health professionals involved in the research. All the images were sent to the reference hospital (General University Hospital of Alicante).

All the retinographs were assessed by 2 ophthalmologists of the reference hospital Ophthalmology Service, Retina Section, by means of a 17-inch TFT high resolution screen. After assessing the images, the diagnostic was developed following the American Ophthalmology Academy Classification18 as no retinopathy, slight nonproliferative DR, moderate, severe and proliferative DR, as well as the presence of macular edema on the basis of the presence of hard exudates at <500 µ of the fovea. Subsequently, the ophthalmologist issued a report for each patient describing the recommendations to be followed, i.e., annual assessment in the absence of DR, assessment at the Specialties Center with slight or moderate DR or in the presence of opacity preventing retinography assessment or in the presence of other diseases (ARMD, vascular thrombosis, epiretinal membrane, papilla cup suspicious of glaucoma, atypical nevus, etc.). The patients with severe nonproliferative and proliferative DR or with maculopathy...
were directly requested to attend the hospital for fluorescein angiography (FA) and laser treatment.

**Results**

The prevalence of patients with some degree of DR was of 17.90% (436 patients with retinopathy out of 2435 diabetic patients). Of these, 350 had slight and moderate nonproliferative DR (80.73%), 55 patients had severe nonproliferative DR (12.16%), 10 patients with proliferative DR (2.29%) and 21 patients had diabetic maculopathy associated to some degree of retinopathy (4.82%) (Table 1).

Out of 2435 patients who were assessed, 86 patients who exhibited severe nonproliferative DR, proliferative DR and maculopathy associated to retinopathy were requested to visit the hospital for FA, representing 3.53% of all patients (Table 2).

Overall, 350 patients with signs of slight and moderate DR (14.37%) were referred for assessment to the Specialties Center for assessment by the Ophthalmology Service in a six-month period.

In 53 patients (2.18%) the obtained images were not analyzed due to the presence of opacities in 41 (1.69%) (cataracts, vitreous hemorrhage), or due to the presence of another disease in 12 (0.49%) (ARMD, suspected glaucoma, suspected choroidal nevus) and were referred to the Specialties Center.

Overall, 1946 (79.92%) assessed diabetic patients did not exhibit signs of DR and therefore benefited from the DR screening without requiring the conventional ophthalmological assessment.

**Discussion**

This article presents the results of the first work on DR screening and telemedicine carried out in the province of Alicante comprising 2435 diabetic patients.

The retinographies were taken by a technician of Health Area 19 and transmitted through the Intranet to the Ophthalmology Service of the General University Hospital of Alicante. Three 45° retinographs were obtained according to the Joslin Vision Network protocol.20 The risk involved in taking a higher number of photographs is that quality can diminish due to pupil miosis induced by repeated flashes.

Digital ocular fundus photographs have the advantage that they can be obtained at minimum cost and discomfort for the patient and can be electronically transmitted for assessment by experts. Numerous papers have demonstrated that ophthalmological screening of diabetic patients with non-mydriatic camera is one of the health interventions with the best cost-effectiveness ratio9,11,12 in addition to being a method with high sensitivity and specificity.3,13

The prevalence of patients with DR was of 17.90%, in the lower limits when compared with other published papers10,11,14,16,19,21 which ranged between 17.2 and 30%, perhaps due to the fact that in our study the patients who were already diagnosed with DR were excluded. The DR international clinical classification system recommended by the AAO was utilized, matching the work recently published by Vleeming et al.,19 obtaining lower DR prevalence in our study (17.90%) vis-à-vis other published papers.16,19

Eighty-six patients (3.53%) were requested to attend the hospital for FA study and laser treatment (severe nonproliferative DR, proliferative DR or maculopathy). With this DR screening method, these patients obtained early diagnostic and treatment.

Diabetes is a chronic disease and following the recommendations of the Retina Panel of the American Association of Ophthalmology for reviews, the application of the usual ocular fundus exploration technique, comprising miidriasis, slit lamp and 78 D lens would cause a work overload that could prevent annual assessment of all diabetic patients.

In our health area there is a 3-month waiting list for ophthalmological outpatient assessments. When the ophthalmologist identifies treatable retinopathies, the patient is derived to the Posterior Pole Practice of the Hospital with a delay of a further 2–3 months.

With the DR screening method with non-mydriatic camera, diabetic patients visit the primary health care practice and are requested to attend the reference health center for retinographies with an interval of under 3 days because the images are taken daily without waiting lists for retinographies. The procedure of exporting and importing images takes on average 8 days. Patients with retinopathies for FA study and treatment are requested to attend the Posterior Pole practice directly with a maximum interval of 15 days from the date when the retinographies were taken. The only patients referred to the outpatient ophthalmological practice are those exhibiting retinopathy without indication for treatment, while patients without retinopathy would be requested to attend an annual assessment with non-mydriatic camera.

Accordingly, the application of telemedicine reduces the workload of outpatient ophthalmological practices and saves time in the diagnostic and treatment, avoiding delays which in some cases can produce severe problems for patients.

Screening of diabetic patients with retinographies obtained with non-mydriatic cameras is a highly valid method which enables the assessment of large diabetic populations and the

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<th>Table 1 – Prevalence of diabetic retinopathy.</th>
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<td>Retinopathy</td>
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<td>-------------------------------------------</td>
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<tr>
<td>Non-proliferative, slight and moderate</td>
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<td>Non-proliferative, severe</td>
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<td>Proliferative DR</td>
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<td>Macular edema plus DR</td>
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<th>Table 2 – Final report of assessed patients.</th>
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<td>Report</td>
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<tr>
<td>Annual assessment with non-mydriatic camera</td>
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<tr>
<td>Assessment in specialties center (slight or</td>
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<tr>
<td>moderate nonproliferative DR)</td>
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<tr>
<td>Hospital practice (FA/laser)</td>
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<tr>
<td>Assessment in specialties center (poor</td>
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<td>visualization, other diagnostics)</td>
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detection of those which exhibit DR in early stages or are candidates for treatment, preventing in this manner the evolution of DR to more advanced stages.

The above-described screening method exhibits significant potential due to the expected growth in the number of diabetic patients in the future and the small number of ophthalmologists to carry out assessments. The participation of trained technical staff can assist in the extension of screening DR patients to cover larger populations.

In addition, it has the advantage of enhancing the relationship between primary and specialized healthcare.

**Conflict of interests**

No conflict of interests has been declared by the authors.

**References**