Automatic identification and classification of diabetic macular edema using optical coherence tomography images

María Isabel Fernández[3,4,5], Marcos Ortega[1,2], Pablo Almuiña Varela[4,5], María Gil Martinez[3,4], Joaquim de Moura[1,2], Gabriela Samagaio[1,2], Jorge Novo[1,2], María José Rodriguez Cid[4,5], Maximino José Abraldes López-Veiga[3,4,5], and Francisco Gómez-ulla[3,4,5]

[1] Department of Computer Science, University of A Coruña, A Coruña, (Spain)
[2] CITIC - Research Center of Information and Communication Technologies, University of A Coruña, A Coruña, (Spain)
[3] Instituto Oftalmológico Gómez-Ulla, Santiago de Compostela, (Spain)
[4] Department of Ophthalmology, Complejo Hospitalario Universitario de Santiago, Santiago de Compostela, (Spain)
[5] University of Santiago de Compostela, Santiago de Compostela, (Spain)

1 Purpose

The automatic identification of the progressive intraretinal fluid accumulation constitutes a crucial ophthalmological issue as it provide useful information for the diagnosis, treatment and monitoring of the evolution of the different types of Diabetic Macular Edema (DME), even in early stages of this relevant disease.

Our aim was to develop a new computational tool for the identification of the three types of DME using Optical Coherence Tomography (OCT) images. This fully automatic system facilitates the clinical experts in the diagnostic process of the patients with DME disease, enabling adjusted treatments without the need for further invasive studies.

2 Setting/Venue

DME is a leading cause of visual impairment in the diabetic population. OCT has become a very useful non-invasive imaging modality to study in vivo different healthy and pathological ocular structures. Advances in this technology include the study of qualitative and quantitative biomarkers of great clinical interest.

3 Methods

The proposed system used OCT images that were acquired with a SD-OCT imaging Spectralis from Heidelberg Engineering. We reviewed a total of 170 OCT images centered in the macula, with a resolution of 2032×596 pixels. The OCT images were analyzed, belonging to 20 healthy patients and 150 patients

diagnosed of DME, that were categorized in three types: Serous Retinal Detachment (SRD), Diffuse Retinal Thickening (DRT) and Cystoid Macular Edema (CME).

The proposed methodology is divided into three main steps. Firstly, the system automatically delimits the boundaries of the main retinal layers to extract the region of interest in the OCT image. In particular, two retinal regions are extracted: one corresponding to the inner retina and other for the outer retina. Then, the system localizes the DME presence inside those retinal regions. For that, the method combines different clinical knowledge (position, dimension, shape and morphology) with image processing techniques (for the SRD and CME cases) as well as machine learning strategies (for the DRT case) to identify the presence of all the existing DME cases. Finally, the method presents, as output, a labelled OCT image with all the identified DME cases, correctly characterized by type.

4 Results

The proposed method was validated using a set of 170 OCT images. The images correspond to OCT scans from both left and right eyes of different patients, presenting a varying degree of the DME types in a single OCT scan. This study was designed as a statement of ethical principles for medical research and following the tenets of the Declaration of Helsinki.

In order to test the performance of the proposed system, the images were labelled by an expert clinician, identifying the location of all DME types. The system was validated using statistical metrics that are commonly used in the state-of-the-art to measure the performance of similar computational proposals.

In the case of CME type, the method reaches a global F-Measure of 91.99% for both regions (inner and outer retina), while the identification of the DRT achieves a value of 87.54% for the F-Measure. Regarding the SRD edemas, the system was capable to adequately identify all the cases of this DME that were presented.

5 Conclusions

Despite the high variability and complexity of this relevant retinal disease, the proposed method offered an accurate performance for the individual identification of the three different types of DME (SRD, CME and DRT) using OCT images. In fact, this fully automatic system is capable of handling the DME analysis even in cases of significant severity with the simultaneous existence of the three DME types that can appear merged inside of the retinal layers. Therefore, the system offers an auxiliary tool for clinical assessment, which facilitates the early evaluation of the presence or absence of the accumulation of intraretinal fluids, as well as the corresponding diagnostic procedures for DME disease.