Clinical decision support tool for the identification of pathological structures associated with age-related macular degeneration

Iván Barrientos[1,2], Joaquim de Moura[1,2*], Jorge Novo[1,2], Marcos Ortega[1,2], and Manuel G. Penedo[1,2]
{ivan.barrientos.lema, joaquim.demoura, jnovo, mortega, mgpenedo}@udc.es

[1] Grupo VARPA, Instituto de Investigación Biomédica de A Coruña (INIBIC), Universidade da Coruña, A Coruña, (Spain)
[2] Centro de investigación CITIC, Universidade da Coruña, A Coruña, (Spain)

Abstract. This paper presents a clinical decision support tool for the identification of pathological structures associated with age-related macular degeneration (AMD) using optical coherence tomography (OCT) and optical coherence tomography angiography (OCT-A) images. The system provides a useful tool that facilitates clinical decision-making in the diagnosis and treatment of this relevant disease.

Keywords: Computer-aided diagnosis, Optical Coherence Tomography, Optical Coherence Tomography Angiography, Age-Related Macular Degeneration

1 Introduction

Age-related macular degeneration (AMD) represents one of the main causes of vision loss in older adults. This relevant disease is associated with age and gradually deteriorates central vision. AMD mainly affects peripheral blood vessels, causing different signs of systemic and retinal vascular impairment. In more advanced stages, blood vessels start to grow from the choroid (the region of blood vessels under the retina) and penetrate the main retinal tissues, leading to fluid leakage and thus severe retinal damage. Currently, clinicians use different imaging modalities to diagnose AMD. In particular, optical coherence tomography (OCT) and optical coherence tomography angiography (OCT-A) are emerging ophthalmic imaging technologies with great potential to support early diagnosis of this relevant pathology. On one hand, OCT is a non-invasive imaging technique that uses low-coherence light to capture two and three dimensional images of micrometer resolution within optically scattering media (e.g., biological tissues). OCT is based on low-coherence interferometry, which typically uses near-infrared light. The use of long wavelength light allows penetration of the scattering medium. This capture device allows us to obtain detailed images of the inner retina. On the other hand, OCT-A is a more recent technique for the capture of high-resolution images of the choroidal and retinal circulation. This

ophthalmologic test is performed without the injection of a contrast medium and is therefore a non-invasive technique. Being non-invasive, it does not cause any damage to the eyeball and can therefore be performed repeatedly. This technique is used for fundus analysis, being able to generate images of the retinal vascular structure at different depths, based on the detection of blood flow movement.

2 Methodology

In this work, we present a clinical decision support tool for the identification of different pathological structures associated with AMD using OCT and OCT-A images. For this purpose, we have designed a fully automatic solution based on deep learning, which is initially composed of 3 modules. A first module that automatically distinguishes between OCT and OCT-A images; it is useful to differentiate the type of image we are working with for an accurate and efficient diagnosis. The second module is able to differentiate healthy patients from those with the following pathologies on OCT images: choroidal neovascularization, diabetic macular edema and drusen. The third module is able to automatically classify the OCT-A images as retinal vein occlusion or healthy.

3 Results and Conclusions

Two datasets have been used for the validation of this work. The first dataset is composed of 84,484 OCT images differentiated into four classes: 26,315 images of healthy patients, 37,205 images of patients diagnosed with choroidal neovascularization, 11,348 images of patients diagnosed with diabetic macular edema and 8,616 images belonging to patients diagnosed with drusen. The second dataset is composed of 1,551 OCTA images differentiated into two classes: 870 images of patients diagnosed with retinal vein occlusion and 681 images of healthy patients. The proposed system provided accurate results in all designed modules, demonstrating enormous potential in the early diagnosis, treatment and monitoring of AMD.

Acknowledgements

This research was funded by Instituto de Salud Carlos III, Government of Spain, DTS18/00136 and PI17/00940 research projects; Ministerio de Ciencia e Innovación y Universidades, Government of Spain, RTI2018-095894-B-I00 research project; Ministerio de Ciencia e Innovación, Government of Spain through the research project with reference PID2019-108435RB-I00; Consellería de Cultura, Educación e Universidade, Xunta de Galicia, Grupos de Referencia Competitiva, grant ref. ED431C 2020/24 and postdoctoral grant ref. ED481B 2021/059; Axencia Galega de Innovación (GAIN), Xunta de Galicia, grant ref. IN845D 2020/38; CITIC, Centro de Investigación de Galicia ref. ED431G 2019/01, receives financial support from Consellería de Educación, Universidade e Formación Profesional, Xunta de Galicia, through the ERDF (80%) and Secretaría Xeral de Universidades (20%).