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ORIGINAL ARTICLE

Accuracy of peripapillary versus macular vessel density in diagnosis of early to advanced primary open angle glaucoma☆

Intérêt de la mesure de la densité vasculaire maculaire et peri-papillaire par OCT-angiographie dans le diagnostic du glaucome débutant à avancé

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KEYWORDS
Optical coherence tomography angiography;
Open-angle glaucoma;
Optic disc perfusion;
Macular perfusion;
Early diagnosis

Summary
Purpose. — To evaluate macular and peripapillary vessel density (mVD, pVD) using optical coherence tomography angiography (OCT-A) in healthy subjects, patients with ocular hypertension (OHT) and primary open-angle glaucoma (POAG) patients.
Methods. — In this prospective observational study, OCT-A images were obtained from 60 eyes of 36 healthy, ocular hypertension (OHT), preperimetric glaucoma (PPG), early glaucoma (EG) and moderate and advanced POAG subjects. Superficial mVD was acquired over a 6×6-mm cube centered on the foveal avascular zone and pVD over a 4.5×4.5-mm cube centered on the optic disc. Peripapillary retinal nerve fiber layer (pRNFL) and ganglion cell complex (GCC) thickness was calculated using spectral-domain OCT. Correlations between vascular, structural and Humphrey VF indices were evaluated (Spearman's rank correlation coefficient).

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Results. — Median pVD and mVD in the PPG eyes were lower than in healthy eyes (51.87% and 47.23% versus 55.70% and 53.61%, respectively; $P < 0.001$ and $P = 0.003$), but higher than in mild glaucoma eyes (46.21% and 41.98%, $P < 0.001$ compared to normal eyes) and moderate to advanced glaucoma eyes (37.45% and 39.89%, $P < 0.0001$ compared to normal eyes). The highest correlations were found between structural parameters and pVD ($r = 0.87$ and 0.86 for pRNFL and GCC, $P < 0.0001$), followed by mVD ($r = 0.69$ for both pRNFL and GCC, $P < 0.0001$). Correlations with mean VF sensitivity were similar for pVD and mVD ($r = 0.61$ and 0.56) and for GCC and pRNFL ($r = 0.60$ and 0.52, $P < 0.0001$ for all).
Conclusions. — VD measured with OCT-A shows reduction in POAG. Detection of this damage differentiates PPG from normal and perimetric POAG eyes with a high correlation with structural parameters. Peripapillary VD accuracy is higher than mVD in detecting the disease. These results suggest that OCT-A could improve POAG diagnosis and understanding of the pathophysiologic mechanisms behind glaucoma.

MOTS CLÉS
OCT-angiographie ;
Glaucome à angle ouvert ;
Perfusion du disque optique ;
Perfusion maculaire ;
Diagnostic précoce

Résumé
Objectif. — Évaluer la densité vasculaire superficielle maculaire et peri-papillaire (mDV et pDV) par OCT-angiographie (OCT-A) chez des patients sains, hypertones (HTO) et atteints de glaucome primitif à angle ouvert (GPAO).
Méthode. — Dans cette étude prospective observationnelle, 60 yeux de 36 patients contrôles, HTO ou GPAO pré-périmétriques (GPP), débutants (GD) et modérés à avancés (GMA) ont bénéficié d'une mesure des pDV et mDV par OCT-A, d'une mesure de l'épaisseur des fibres nerveuses rétiniennes peri-papillaires (RNFL) et du complexe ganglionnaire maculaire (CGM) par OCT spectral domain, et d'un champ visuel (CV). La corrélation entre ces différents paramètres était évaluée (r : coefficient de corrélation de Spearman).
Résultats. — Les pDV et mDV moyennes des patients GPAO étaient significativement abaissées (patients contrôles : 55,70 % et 53,61 % respectivement ; GPP : 51,87 % et 47,23 % $p < 0,05$; GD : 46,21 % et 41,98 % $p < 0,001$; GMA : 37,45 % et 39,89 % $p < 0,0001$). Il n'existait pas de différence significative de ces paramètres entre les patients contrôles et HTO. Le plus fort coefficient de corrélation était retrouvé entre les paramètres pDV et RNFL ($r = 0,87$), suivis de pDV et CGM ($r = 0,86$), mDV et RNFL ($r = 0,69$), mDV et CGM ($r = 0,69$), pDV et CV ($r = 0,61$) et mDV et CV ($r = 0,56$).
Conclusion. — La densité vasculaire superficielle est réduite en cas de GPAO, dès le stade pré-périmétrique de la maladie, avec une forte corrélation aux paramètres structurels. La valeur diagnostique de pDV serait supérieure à celle de mVD. L'OCT-A pourrait améliorer le diagnostic et la compréhension des mécanismes physiopathologiques à l'origine du glaucome.

Introduction

Glaucoma is the leading cause of irreversible blindness worldwide with around 65 million people affected to date, and twice as many patients expected in 2040 [1]. Major epidemiologic studies demonstrated that early diagnosis and treatment of the disease were key determinants to reduce the risk of progressive and irreversible visual loss, since advanced-stage glaucoma is in itself a risk factor for progression of the disease [2—4].

To date, as defined by the 10th World Glaucoma Association consensus, detecting progressive glaucomatous peripapillary retinal nerve fiber layer (pRNFL) thinning and neuroretinal rim narrowing are the best currently available good standards for glaucoma diagnosis while detection of visual field (VF) defects is indispensable for documentation and monitoring of functional decline in the disease.

White-on-white standard automated perimetry (SAP), the standard used to assess visual function, is not appropriate to diagnose the earliest stages of glaucoma since a significant amount of ganglion cell (GC) loss is expected to have occurred (25—50%) before functional deficits are detected [5]. Selective perimetry techniques, including short-wavelength automated perimetry (SWAP) and frequency-doubling technology (FDT) perimetry, have been developed to provide earlier detection of GC loss, but these devices have been widely supplanted nowadays by optical coherence tomography (OCT), whose performance allows better detection and monitoring of preperimetric glaucoma (PPG). Conversely, in advanced glaucoma some evidence