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OCTA 在原发性开角型青光眼眼底微循环改变中的应用现状①

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摘要　原发性开角型青光眼(POAG)是青光眼的常见类型,其发病隐匿、早期症状不明显,患者就诊时往往已经进展到晚期,对视力损害极大。视力下降、视野改变、视网膜神经纤维层厚度的改变等是 POAG 的主要诊断依据,早期缺乏有效的监测工具。近年来,OCTA 技术以安全无创、无不良作用,能快速清晰实时成像为主要特点,已广泛应用于眼科临床,成为 POAG 早期监测眼底损害的全新手段,其也可用于评价疗效与随访。本文就 OCTA 在原发性开角型青光眼眼底微循环改变中的临床应用进行简要综述。

关键词:原发性开角型青光眼;光学相干断层扫描血管成像;微循环
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Application status of OCTA in the ocular fundus microcirculation changes in patients with primary open-angle glaucoma[①]

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Abstract　Primary open-angle glaucoma(POAG) is a common type of glaucoma, whose onset is insidious and the early symptoms are not obvious. By the time the patient sees a doctor, it has generally progressed to the advanced stage, causing great visual impairment. Vision loss, visual field change, and changes in retinal nerve fiber layer thickness and the like are the main diagnostic criteria for POAG. However, there is a lack of effective monitoring tools for POAG patients in the early stage. The optical coherence tomography angiography(OCTA) technology, which has developed rapidly in recent years, is safe, non-invasive, with no side-effects, and it is fast and clear, and real-time imaging. It is widely used in ophthalmology clinics and has become a new method to monitor ocular fundus damage in the early stage for POAG patients. Authors in this article briefly review the clinical application of OCTA to the changes of fundus microcirculation in patients with POAG.

Keywords: primary open angle glaucoma(POAG); optical coherence tomography angiography(OCTA); microcirculation

原发性开角型青光眼(primary open angle glaucoma,POAG)是青光眼的常见类型,其发病机制不明确,目前主要有机械压力学说、血管学说、基因学说。一般认为青光眼视神经损害可能是遗传易感因素基础上机械压力和缺血的综合作用结果。POAG 的诊断主要依据视野改变、视网膜神经纤维层厚度的改变,早期缺少有效的监测工具,对于其认知和治疗也多基于机械学说。近年来,光学相干断层扫描血管成像(optical coherence tomography angiography,OCTA)发展迅速,针对青光眼眼底微循环改变的研究越来越多。OCTA 安全无创、无副作用、快速清晰实时成像,是一种眼底局部血流运动成像监测技术。它可以分层显示并分析视网膜、视盘及脉络膜血管网信息,也可以提供高分辨的三维血管图像。同时,OCTA 也能定量分析、计算包括视网膜血流面积、黄斑区血流密度及无灌注区的面积等视网膜微循环改变情况[1-4]。其首次实现了在活体上对眼底微循环的血流分析达到人体组织学和解剖学水平。OCTA 通过监测视网膜、视盘微循环改变情况,很好地诠释了青光眼发病的血管学说机制,因此其可以作为 POAG 早期眼底损害监测的全新手段,也可评价其疗效并对其进行长期随访。本文针对 OCTA 在 POAG 中眼底微循环改变中的临床应用进行一简要综述。

1　OCTA 基本工作原理及其优劣势

OCTA 工作原理是对局部视网膜的同一位置进行连续的 B 扫描,接收血管内流动的红细胞信号和临近组织反射信号,然后进行分析计算并重建出三维的血流图像[5]。在一定范围内,反射信号与血流速度呈线性关系,即反射信号越高代表血流速度越快[6]。眼球运动、血液流动、组织的布朗运动等是影响血流成像质量的重要因素,分频幅去相干血管成像程序算法大大提高了相关 OCTA 的血流成像质量。

应用 OCTA 的优势:①安全无创,是无创非接触式检查手段;②方便快捷;③眼底成像质量高;④三维成像,对视网膜的分层分析达到组织解剖水平;⑤血管参数可量化,黄斑区血流密度、无灌注区面积等都可量化。

OCTA 的局限性:①扫描范围小,主要集中在后极部;② OCTA 无法动态显示眼底血管改变情况及血管的渗漏和着染情况;③屈光间质混浊和固视不良者影响成像质量;④血流投射伪影的影响,有时难

以识别异常血管;⑤太快或太慢的局部血流信号无法准确捕捉,个别情况下需要手动调节血流分层。

2 OCTA 在原发性开角型青光眼眼底微循环改变中的临床应用

目前,OCTA 技术在原发性开角型青光眼中主要用于监测视盘周围血流改变、黄斑区血流改变、视网膜神经纤维层厚度、脉络膜血流改变等。其也应用于原发性开角型青光眼合并高度近视的诊断[7],以及观察高度近视合并原发性开角型青光眼和生理性大视杯患者视盘、黄斑区血管密度的改变[8]。

2.1 POAG 患者视盘周围血流的改变

视盘主要由睫状后动脉(posterior cilliary arteries, PCA)供血,软脑膜血管和视网膜中央动脉(central retinal artery,CRA)也可为其供血。筛板后区供血因血管解剖的个体差异而不同,有些个体单独由 PCA 循环供血,而有些个体需要 PCA 和 CRA 共同参与供血。OCTA 能在不同层次上呈现盘周放射状毛细血管网的结构细节,Mase 等[9]研究发现健康人盘周毛细血管网在盘周处呈放射状向周边下降,随神经纤维层(retinal nerve fiber layer,RNFL)厚度降低而明显减少。

高眼压、视网膜脉管系统变化、供血不足、免疫等因素与 POAG 患者视神经损害密切相关[10-11]。视盘血管微循环的异常对于 POAG 的早期诊断及病情进展的预测、治疗效果的评估等都有重要参考意义。因此,国内外近年利用 OCTA 在青光眼方面的研究主要集中在盘周血管微循环改变。有学者研究发现青光眼患者视盘区的血管密度、RNFL 厚度较正常对照组下降[12-13]。Scripsema 等[14]利用 OCTA 证实了 POAG 组和正常眼压性青光眼(normal tension glaucoma,NTG)组较正常组盘周毛细血管密度降低,POAG 组较 NTG 组环状毛细血管密度也降低。此外,研究证实在视盘区结构及功能指标的改变之前就已经出现了青光眼血流密度的改变,所以通过 OCTA 检测视盘的血流参数可在 RNFL 损伤、视网膜神经节细胞(retinal ganglioncell,RGC)减少或视野改变之前发现青光眼的病情进展[15-18]。研究青光眼性视神经损伤与血流改变之间的关系,为 OCTA 定量检测视盘区的血管密度提供了重要依据[19]。

2.2 POAG 患者黄斑区血流的改变

人眼视觉最敏锐的黄斑区主要分布了大量的神经节细胞。青光眼患者视神经损伤与否,可通过观察视网膜神经节细胞和内丛状层厚度来判断[20]。同时,与浅表神经丛相比,神经节细胞中黄斑部血管密度与青光眼的功能损害密切相关[21]。

OCTA 应用于 POAG 患者黄斑区血流改变主要包括:定量分析黄斑区血管密度改变、血流改变,以及黄斑区视网膜神经节细胞层厚度。研究显示,早期发现 POAG、监测 POAG 的进展可通过测量黄斑区微循环参数以及图形视网膜电图和图形视觉诱发电位来实现[22]。仲妍等[23]研究发现 POAG 患者黄斑区血管密度、黄斑视网膜神经节细胞层厚度、黄斑全层厚度与视野平均缺损值(mean defect,MD)均呈线性正相关,其具有较高的青光眼诊断价值。利用 OCTA 也能观察 POAG 患者黄斑区神经节细胞层内的血流改变,Richter 等[24]发现 POAG 患者黄斑区内神经节细胞内丛状层微循环较正常人改变明显。研究表明,POAG 患者中黄斑血管密度降低与 RNFL 和神经节细胞复合体(ganglion cell complex,GCC)降低有关,POAG 患者黄斑区血管密度与神经损伤之间存在着一定联系[25]。

2.3 POAG 患者视网膜神经纤维层的改变

与多种因素相关的视神经进行性损伤是青光眼的显著特征,局部 RNFL 的损伤会导致视乳头旁视网膜微血管的损害,继而出现血流减少[26]。有研究发现,视盘周围血管密度改变与视神经纤维层厚度变化密切相关,POAG 常会引起视乳头周围 RNFL 厚度变薄[27]。也有研究发现,伴有脉络膜毛细血管层扇形缺损的青光眼具有较低的 RNFL 厚度[28-29]。

2.4 POAG 患者脉络膜血流的改变

在维持外层视网膜高代谢中丰富的脉络膜血流起着重要的作用[30]。长期高眼压会压迫脉络膜血管致脉络膜血流减少。Akahori 等[31]的研究进一步证实眼压升高后可引起脉络膜血流的减少,从而导致脉络膜厚度(choroidal thickness,CT)变薄;同时,高眼压状态下脉络膜血管直径减小或(和)脉络膜毛细血管塌陷也可导致 CT 变薄[32-33]。高眼压会影响

脉络膜血流,视乳头旁受损的脉络膜微循环改变情况可通过 OCTA 扫描呈现出来。脉络膜微血管脱落(choroidal microvascular dropout,CMvD)出现在原发性闭角型青光眼(primary angle closure glaucoma,PACG)进展过程中,Rao 等[32]利用 OCTA 扫描脉络膜图像发现,与 PACG 患者相比,POAG 患眼中 CMvD 更明显。

3 总结

OCTA 技术近年发展迅速,利用 OCTA 观察眼底血管微循环改变,有助于更好地诊断视网膜脉络膜疾病、青光眼和神经眼科疾病,进一步加深对这些疾病发病机制的理解,从而对相关眼病进行有效地监测及随访[34-35]。目前,OCTA 在青光眼的临床中应用广泛,并且已经取得一定成效。但是,POAG 的诊断、疗效评价以及追踪随访是基于多方面、多层次的,OCTA 并不能完全取代像视野、眼压等一些传统的检查,在临床工作中需要合理应用、综合分析。

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