Evidence of Post Trabeculectomy Optic Nerve Reperfusion by OCT Angiography

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Author’s contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

Aim: To describe a case of glaucoma which showed increase in optical coherence tomography (OCT) angiographic vessel densities after intraocular pressure reduction suggesting reperfusion of optic nerve.

Presentation of Case: A 55 year old female with primary open angle glaucoma was taken up for trabeculectomy in view of inadequate control of intraocular pressure (IOP) despite maximal medical therapy. In addition to routine glaucoma assessment by visual fields and nerve fiber layer assessment by OCT, OCT angiographic evaluation of peripapillary vessel density was done preoperatively. Three months after trabeculectomy, her intraocular pressure decreased from 35mmHg to 14mmHg. Compared with the preoperative baseline value, the vessel density increased significantly in all quadrants after three months from surgery as demonstrated by OCT angiography.

Discussion: This case report suggests that decreased optic nerve head perfusion due to high IOP can be reversed by reduction of IOP.

Conclusion: Vascular parameters like angiographic vessel density can show reversible changes as decreased blood flow reinstates and thus can be better prognostic indicators than structural parameters like OCT retinal nerve fiber layer (RNFL) in glaucoma patients.

Keywords: OCT Angiography; vessel density; ocular perfusion; trabeculectomy.
1. INTRODUCTION

Optical coherence tomography—angiography (OCT-A) gives a three-dimensional, non-invasive retinal and choroidal microcirculation vasculature imaging.

Data derived from OCT-A has shown that peripapillary vessel density, flow index and optic disc perfusion are reduced in glaucomatous eyes compared with age-matched normal eyes [1-5]. Some studies have also reported decreased macular vessel density in glaucoma patients [6]. This decrease in vessel density progresses as glaucoma severity increases. However it is unclear whether this vessel density which decreases as a result of high intraocular pressure (IOP) insults could be reversed if the IOP was again controlled. We describe a case of advanced primary open angle glaucoma which showed reperfusion of the optic nerve in the form of increase in peripapillary and macular vessel density after IOP reduction by trabeculectomy.

2. PRESENTATION OF CASE

We report a case of a 55 year old female who presented to us for uncontrolled IOP in her right eye. She was being managed elsewhere and was on maximally tolerated medical therapy. On presentation her best corrected visual acuity was 6/6 in both eyes. IOP was 35 mm Hg and 18mmHg with central pachymetry being 537 and 542 in the right and left eye respectively. Slit lamp examination was unremarkable in both eyes and the anterior chamber was deep. Gonioscopy showed open angles in both eyes and the anterior chamber was deep. Fundus exam showed C/D: 0.7 in the right eye and C/D: 0.5 in the left eye with bipolar thinning and deep cup in both eyes. Bayonetting and nasal shift of vessels were evident. Macula, vessels and periphery were within normal limits in both eyes. The patient underwent visual fields examination which revealed bi-arcuate scotoma in the right eye and superior arcuate scotoma in left eye. OCT nerve fiber layer assessment showed decreased nerve fiber layer density in all quadrants (red zones) in the right eye and in the inferior, inferotemporal and inferonasal quadrants in the left eye. Macular ganglion cell complex showed severe thinning (red zones) in the right eye and was normal in the left eye. All these suggested advanced glaucomatous changes in the right eye and moderate changes in the left eye. OCT-A 6*6 disc scan and 3*3 macula scan was done by Angioplex (Cirrus HD-OCT 5000, Zeiss Meditec, Inc.) preoperatively.

Patient underwent an uneventful trabeculectomy with a 4*4 triangular flap and releasable sutures for the right eye. Postoperatively she was put on antibiotic steroid combination drops and atropine drops. On postoperative day one, IOP was 20mm Hg. On examination, the eye was quiet with a well formed bleb (Indiana bleb grading, H2E2V2S0). The patient was stable and followed up every fortnight. After three months from surgery, OCT-A was repeated for the operated eye. Both peripapillary (Fig. 1a-b pre and postoperative respectively) and macular scans (Fig 2a-b pre and postoperative respectively) showed improvement of vascular density in all sectors as measured by automated software for measurement of vessel density in Angioplex.

3. DISCUSSION

The retinal microvasculature, especially radial peripapillary capillaries, are the main source of nutrition for retinal ganglion cells [7]. Under effects of high IOP, there is a decreased blood supply to these nourishing vessels of the retinal ganglion cells. Assessment of microvascular impairment can thus be useful for monitoring patients with glaucoma.

It has been investigated using multiple imaging modalities that there is a link between ocular perfusion and glaucoma [1,2]. Optic nerve head blood flow of glaucoma patients after trabeculectomy has been investigated by fluorescein angiography [8], colour doppler imaging [9], pulsatile ocular blood flow by fundus pulsation amplitude [10], scanning laser doppler flowmetry [10,11]. Optical coherence tomography angiography (OCT-A) gives a three-dimensional, non-invasive retinal and choroidal microcirculation vasculature imaging [12].

The emerging literature in OCT-A has been able to establish that vessel densities in the peripapillary and macular areas are lower in glaucoma patients when compared to normal population [1,5]. However there is still a paucity of literature on improvement of microvasculature in glaucoma patients if the IOP is lowered. Zeboulon et al. [13] in their study using OCT-A demonstrated a very limited effect of surgically induced IOP reduction on peripapillary and macular vessel density but the study had a very short follow up of 1 month. One might argue that one month is a very short time to re-develop lost vascular networks. Other studies have reported that although structural parameters like OCT retinal nerve fiber layer (RNFL) thickness do not

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change even with IOP reduction, a change in OCT-A is apparent [14,15]. Our case did not see any lamina cribrosa depth reduction as opposed to a study which reported it post trabeculectomy [15]. The quantitative assessment in our case at the image procurement level itself ensured that no details were lost in image transfers for analysis. Our case saw an increase in peripapillary as well as macular vessel densities at three month after surgery. This suggests a need for following such patients for a longer time. Alnawaiseh et al. [16] demonstrated the improvement of the vasculature in the form of flow density enhancement of the macular and optic nerve head after cataract surgery with intent implantation.

Reversibility of decreased blood flow of the optic nerve head in glaucoma patients has been documented in our patient post trabeculectomy with the help of OCT-A. Elevation of IOP is well known to affect retinal perfusion. We hypothesise that as the mechanical effect of high IOP wanes off after surgically or medically controlling IOP, ocular blood flow re-establishes itself either in pre-existing vascular channels or by formation of new vascular channels. Currently the differentiation between the two is not possible as OCT-A detects only movement of blood cells and not the actual density and distribution of blood vessels. The possibility of formation of new vascular channels in peripapillary area although very less, cannot be denied completely. Further structural studies on ocular vascular models are required to confirm this hypothesis.

In glaucoma patients, after surgical intervention, it is mostly only the IOP which remains a follow up parameter. Other investigative modalities are either visual fields that usually do not pick up minor changes and OCT RNFL which does not demonstrate any further structural change in advanced glaucoma (also known as floor effect). In such a setting it becomes very important to have another quantitative factor whose change can be monitored as an index of improvement. Hence there is a growing need to incorporate OCT-A as a part of diagnostic and prognostic algorithms for glaucoma patients.

![Fig. 1a-b. Pre (a) and post-operative(b) angioplex OCT angiography images of 6*6 mm scan centered around the disc showing increase of vessel density in all sectors postoperatively](image-url)

*Fig. 1a-b. Pre (a) and post-operative(b) angioplex OCT angiography images of 6*6 mm scan centered around the disc showing increase of vessel density in all sectors postoperatively.*

[superior: 19.9(a), 20.3(b) ; inferior: 19.2(a), 19.9(b) ; nasal: 17.1(a), 18.1(b) ; temporal: 19.9(a), 20.2(b)]

Inferior panels of the image show the depth of lamina cribrosa pre and post-operatively.
written participant consent has been collected provides an excellent tool to quantify vessel improvement in glaucoma cases. OCT Increase in optic nerve head blood flow after IOP reduction can be taken as a parameter of improvement in glaucoma cases. OCT-A provides an excellent tool to quantify vessel density in glaucoma cases.

4. CONCLUSION

The fundamental understanding of OCT-A in glaucoma remains mysterious and difficult. Nevertheless OCT-A has definitely emerged as a reliable, objective technique with an acceptable repeatability and reproducibility. If its role in prognosticating patients after surgical or medical intervention is further consolidated by research, it can prove to be a boon for glaucoma professionals.

KEY MESSAGES

Increase in optic nerve head blood flow after IOP reduction can be taken as a parameter of improvement in glaucoma cases. OCT-A provides an excellent tool to quantify vessel density in glaucoma cases.

CONSENT

As per international standard informed and written participant consent has been collected and preserved by the authors.

ETHICAL APPROVAL

As per international standard written ethical permission has been collected and preserved by the author(s).

COMPETING INTERESTS

Author has declared that no competing interests exist.

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