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Optical Coherence Tomography Angiography of Acute Non-Arteritic Anterior Ischemic Optic Neuropathy

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ABSTRACT

Background: Non-arteritic anterior ischemic optic neuropathy (NAION) is an ischemic change involves the 1 mm thickness of the optic nerve head (optic disc). We depend on fundus fluorescein angiography (invasive investigation) and visual field for diagnosis of NAION. Optical coherence tomography angiography (OCT A) is a new modality (non-invasive) for assessment of vascular tissue at multiple retinal levels. We are seeking for a role of OCT A in diagnosis of NAION. **Objective:** The aim of the current study was to assess the optical coherence tomography angiography peripapillary perfusion density in diagnosed non-arteritic acute ischemic optic neuropathy patients within a period from one week to 3 weeks during (acute stage while the disc is still edematous) of acute painless diminution of vision. **Patients and Methods:** This study included a total of ten patients diagnosed with non-arteritic anterior ischemic optic neuropathy and 10 age-matched normal control individuals with normal RNFL thickness, attending at ophthalmology outpatient clinic of Al-Azhar University Hospitals. OCT A 6x6 on the disc is done for all subjects and control group with Zeiss angioplex (cirrus 5000).

Results: showed a decreased perfusion density in a ring from 3 to 6 mm around the center of the disc in all quadrants except the lower one. Central to this ring, the perfusion density is higher in NAION cases, which may be due to superficial displacement of the deeper capillary plexa with edema.

Conclusion: We can depend on the perfusion density in ring 3- 6 mm in diameter when assessing a case of acute NAION not the central circle.

Keywords: Optical coherence tomography angiography, non-arteritic anterior ischemic optic neuropathy, superficial peripapillary plexus perfusion density

INTRODUCTION

Anterior ischemic optic neuropathy (AION) is divided into arteritic anterior ischemic optic neuropathy (AAION) which accounts for 15% and Non-arteritic anterior ischemic optic neuropathy (NAION) which accounts for 85% of cases [(1)].

Non-arteritic anterior ischemic optic neuropathy (NAION) is an ischemic change involves the 1 mm thickness of the optic nerve head (optic disc). It affects around 10 cases per 100,000 per year in the age group over 50 [(2)]. Crowded disc (disc at risk) is the precipitating factor in 97% of patients with NAION [(2)]. Multiple risk factors play a role e.g. obstructive sleep apnea, hypertension and diabetes mellitus [(3)].

Usually the patient with NAION presents in the morning with acute painless diminution of vision with dyschromatopsia. On examination, we can detect relative afferent pupillary defect in the affected eye, segmental or diffuse disc edema surrounded with splinter hemorrhages and decreased C/D ratio in the other eye [(4)]. Arteritic anterior ischemic optic neuropathy (AAION) is the main differential diagnosis. Giant cell arteritis (GCA) (granulomatous necrotizing arteritis) affecting medium sized arteries e.g. superficial temporal and posterior ciliary arteries cause it [(5)].

It is important to differentiate AAION form NAION. As AAION is a lethal disease that leads to total blindness of both eyes. The American college of Rheumatology put 5 criteria for diagnosis of this dangerous disease with sensitivity of 93.5% and specificity of 91.2% by presence of 3 of these 5 criteria. These criteria are age more than 50 years, new onset of localized headache, temporal artery tenderness or lost temporal artery pulse, elevated erythrocyte sedimentation ratio more than 50 mm/hour and biopsy sample including the artery shows necrotizing vasculitis. At that time, patient should be given an intravenous steroid followed by course of oral steroids [(5)]. Optical coherence tomography (OCT) is a non-invasive and interferometric imaging modality developed in 1991 to image the retina in cross section. It improves in its resolution from 15 um to 3 um. OCT detects depth resolved tissue reflectivity characteristics by assessing the interference of light reflected from the biological tissue with reference mirror. This technique depends on time, so called time domain optical coherence angiography [(6)].

TD OCT, another more developed modality depends on frequency called spectral domain optical coherence tomography (SD OCT) using wavelength of 100 nm so the resolution fades with depth. In addition, swept source optical coherence tomography (SS OCT) with wavelength of more than 100 nm (long wavelength) to keep images with good resolution in deep structures. In 2016 FDA approved a new modality called optical coherence tomography angiography (OCT A) depends on detection of moving RBCs in the vessels to detect the blood vessels. Moreover, this technique differentiates vascular tissue at multiple retinal levels (in depth)[(6)].

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OCT A depends on detection of OCT signals from moving particles in contrast to steady particles. Therefore, any moving particle other than RBCs gives signals like RBCs (Brownian like motion) [6]. The aim of the current study was to assess the optical coherence tomography angiography peripapillary area pattern in diagnosed non-arteritic acute ischemic optic neuropathy patients within a period from one week to 3 weeks during (acute stage while the disc is still edematous) of acute painless diminution of vision.

PATIENTS AND METHODS

This study included a total of ten patients diagnosed with non-arteritic anterior ischemic optic neuropathy and 10 age-matched normal control individuals with normal RNFL thickness, attending at ophthalmology outpatient clinic of Al-Azhar University Hospitals. **Approval of the ethical committee and a written informed consent from all the subjects were obtained.** This study was conducted during 2017.

The diagnostic criteria of NAION included history of acute painless diminution of vision, clinical examination of the fundus by fluorescein angiography and visual field.

Inclusion criteria: Clinically diagnosed patients with NAION after complaining of acute painless loss of vision. Age ranged from 40 to 70 years.

Exclusion criteria: Glaucoma, amblyopia, corneal opacity, uveitis, central, branch retinal vein occlusion, central retinal artery occlusion, posterior subcapsular cataract and brown nuclear cataract. Patients shows 3 of 5 criteria for diagnosis of giant cell arteritis in the form of (age more than 50 years, temporal artery tenderness, localized headache, increased ESR and temporal artery biopsy showed granulomatous inflammation).

Observational index: OCT A 6x6 on the disc is done for all subjects and control group with Zeiss angioplex (cirrus 5000). During analysis of images, we use superficial capillary plexus automatically set and put ETDRS grid on the image. ETDRS grid is formed of 3 circles. The central one is 1 mm in diameter, the middle circle is 3 mm and the outer circle is 6 mm. The perfusion density for each circle appears on it.

Statistical analysis

Data were collected, revised, coded and entered to the Statistical Package for Social Science (IBM SPSS) version 23.The quantitative data were presented as mean, standard deviations and ranges. In addition, qualitative data were presented as number and percentages. The comparison between two independent groups with qualitative data was done by using Chi-square test and/or Fisherexact test only when the expected count in any cell found less than 5.

The comparison between two independent groups with quantitative data and parametric distribution was done by using Independent t-test.

The comparison between two independent groups with quantitative data and non-parametric distribution was done by using Mann-Whitney test.

The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant as the following: $P > 0.05$: Non significant. $P < 0.05$: Significant. $P < 0.01$: Highly significant.

RESULTS

Table (1): Shows comparison between normal group and cases group regarding epidemiological data, risk factors and history of the studied cases.

		Control group No. = 10	Cases group No. = 10	Test value	P-value	Sig.
Age (year)	Mean±SD Range	55.100 ± 2.183 51 – 58	56.100 ± 7.460 46 – 71	-0.407•	0.689	NS
Gender	Female Male	8 (80.0%) 2 (20.0%)	6 (60.0%) 4 (40.0%)	0.952*	0.329	NS
Eye	OD OS	5 (50.0%) 5 (50.0%)	6 (60.0%) 4 (40.0%)	0.202*	0.653	NS
Diabetes	No Yes	6 (60.0%) 4 (40.0%)	5 (50.0%) 5 (50.0%)	0.202*	0.653	NS
Hypertension	No Yes	5 (50.0%) 5 (50.0%)	5 (50.0%) 5 (50.0%)	0.000*	1	NS
Interferon alpa intake	No Yes	10 (100.0%) 0 (0.0%)	10 (100.0%) 0 (0.0%)	NA	NA	NA
Sildenafil intake	No Yes	10 (100.0%) 0 (0.0%)	9 (90.0%) 1 (10.0%)	1.053*	0.305	NS
H/O of ophthalmic surgery	No Yes	10 (100.0%) 0 (0.0%)	10 (100.0%) 0 (0.0%)	NA	NA	NA

P-value >0.05: Non significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS)
*:Chi-square test; •: Independent t-test

Table (2): Shows comparison between normal and cases groups regarding visual acuity, pupillary reaction and full perfusion density.

		Control group No. = 10	Cases group No. = 10	Test value	P-value	Sig.
Visual acuity	Mean±SD Range	0.93 ± 0.16 0.500 – 1.000	0.39 0.008 – 1.000	-2.727‡	0.006	HS
Pupillary reaction	NA Sluggish RAPD Reactive	0 (0.0%) 0 (0.0%) 0 (0.0%) 10 (100.0%)	3 (30.0%) 2 (20.0%) 4 (40.0%) 1 (10.0%)	16.364*	0.001	HS
Full perfusion density	Mean±SD Range	0.417 ± 0.024 0.368 – 0.444	0.393 ± 0.068 0.254 – 0.467	1.084•	0.293	NS

P-value >0.05: Non significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS)
*:Chi-square test; •: Independent t-test

Table (3): Shows that there was statistically significant difference found between the two studied groups regarding central circle perfusion density, middle circle perfusion density (superior, inferior, nasal and temporal) and outer circle perfusion density (superior, nasal and temporal) while no statistically significant difference found between them regarding inferior.

Optical coherence tomography angiography perfusion density		Control group No. = 10	Cases group No. = 10	Test value	P-value	Sig.
Central circle perfusion density	Mean±SD Range	0.006 0.000 – 0.047	0.41 ± 0.09 0.260 – 0.531	-3.811‡	0	HS
Middle circle perfusion density						
Superior	Mean±SD Range	0.414 ± 0.047 0.322 – 0.483	0.498 ± 0.046 0.413 – 0.552	-4.078•	0.001	HS
Inferior	Mean±SD Range	0.428 ± 0.044 0.331 – 0.477	0.510 ± 0.040 0.437 – 0.56	-4.360•	0	HS
Nasal	Mean±SD Range	0.407 ± 0.055 0.327 – 0.471	0.477 ± 0.037 0.418 – 0.527	-3.321•	0.004	HS
Temporal	Mean±SD Range	0.353 ± 0.065 0.239 – 0.416	0.421 ± 0.073 0.319 – 0.538	-2.206•	0.041	S
Outer circle perfusion density						
Superior	Mean±SD Range	0.464 ± 0.024 0.43 – 0.503	0.395 ± 0.085 0.243 – 0.485	2.482•	0.023	S
Inferior	Mean±SD Range	0.458 ± 0.034 0.409 – 0.5	0.415 ± 0.076 0.25 – 0.51	1.641•	0.118	NS
Nasal	Mean±SD Range	0.426 ± 0.045 0.303 – 0.457	0.352 0.183 – 0.471	2.285•	0.035	S
Temporal	Mean±SD Range	0.401 ± 0.051 0.312 – 0.46	0.309 0.112 – 0.497	2.117•	0.048	S

P-value >0.05: Non significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS)
•: Independent t-test; ‡: Mann Whitney test

DISCUSSION

In the current study, 10 cases of acute NAION were compared with 10 normal individuals with normal RNFL. We have found a decreased perfusion density in a ring from 3 to 6 mm around the center of the disc in all quadrants except the lower one. Central to this ring, the perfusion density is higher in NAION cases, which may be due to superficial displacement of the deeper capillary plexa with edema. This results are comparable to intercapillary network defects (generalized or sectoral) seen in a case series done by **Rougier *et al.*** [7] comparing 10 patients with acute NAION with their fellow eyes with regard to peripapillary OCT angiography.

Ling *et al.* [8] showed also a comparable data to our study. They observed decreased peripapillary perfusion density in 21 NAION cases compared to 19 normal individuals. Their study differed from ours in that they studied chronic NAION cases (after resolution of disc edema).

Sharma *et al.* [9] published a comparable data to our study. They observed decreased peripapillary superficial perfusion density and choroidal perfusion density. They studied 6 both acute and chronic NAION cases in comparison to 19 normal individuals.

Song *et al.* [10] studied also a peripapillary capillary density in 41 acute, chronic NAION cases in comparison to their fellow eyes and 30 normal individuals. They published comparable data to our study that there is decreased peripapillary perfusion density.

Higashiyama *et al.* [11] published a comparable data to our study. They studied one case with chronic NAION and observed decreased perfusion density in the peripapillary area especially the upper half.

CONCLUSION

It could be concluded that the peripapillary capillary density in acute NAION cases shows statistically significant lower perfusion in a ring 3-6 mm diameter from the center of the disc in comparison to normal individuals. Decreased peripapillary perfusion density doesn't include the lower quadrant. Moreover, the peripapillary capillary density within the central circle 3 mm in diameter is higher in NAION cases than normal.

So, I can depend on the perfusion density in ring 3- 6 mm in diameter when assessing a case of acute NAION not the central circle.

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