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Retinal nerve fiber layer thickness analysis in cases of papilledema using optical coherence tomography – A case control study

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ABSTRACT

Background: Papilledema is defined as an optic disk swelling that is secondary to elevated intracranial pressure. Early diagnosis of papilledema can help in early intervention thus preventing visual loss and even death. Optical coherence tomography (OCT) is a non-invasive imaging technique which can detect and quantify diffuse thickening of the retinal nerve fiber layer (RNFL) in eyes with optic disk edema.
Aims: To assess the difference in the RNFL thickness in patients with papilledema from controls using OCT and to correlate the RNFL thickness with the degree of papilledema.
Setting and design: A case control study was conducted from August 2011 to July 2013 in a tertiary care medical college of south India.
Methods and materials: All adult patients diagnosed or suspected to have papilledema were included in the study. Disk photographs were graded according to modified Frisen criteria. Fast RNFL protocol on time-domain OCT was used. Cases and controls were compared.
Statistical analysis: RNFL thickness was compared using an independent samples *t*-test. Correlation between RNFL thickness and modified Frisen scale of papilledema was done using Spearman correlation. GraphPad InStat 3 version was used.
Results: A total of 100 cases and 126 controls were studied. Statistically significant thickening of retinal nerve fiber layer (RNFL) was seen in all quadrants in patients with papilledema as compared to controls. A positive correlation was found between Frisen grading of papilledema RNFL thickness measurements.
Conclusions: RNFL thickening was mainly in the inferior and superior peripapillary region and was greater in higher grades of papilledema. A strong positive correlation was found between RNFL thickness and the Frisen scale for grading of papilledema. OCT can be included as a routine non-invasive quantitative tool for detection of early papilledema.

1. Introduction

Papilledema is defined as an optic disk swelling that is secondary to elevated intracranial pressure. Papilledema usually presents as a bilateral phenomenon and may develop over hours to weeks. Classical symptoms include headache (characteristically worse on awakening), projectile vomiting and blurring of vision. Fundus examination shows hyperemia of the optic disk, blurring of disk margins, swelling of the optic disk, blurring of peripapillary retinal fiber layer and absence of spontaneous venous pulsations [1].

Optic disk swelling can be graded clinically using modification of Frisen criteria [2].

Optical coherence tomography (OCT) is a non-invasive imaging technique which obtains retinal images closely resembling histologic preparations, and is useful for evaluating the peripapillary nerve fiber layer thickness. OCT can detect and quantify diffuse thickening of the retinal nerve fiber layer (RNFL) in eyes with optic disk edema [3].

Though there are numerous tests used for screening of papilledema, the sensitivity and specificity of each of these objective tests is still being debated. Early diagnosis of papilledema can help in early intervention thus preventing visual loss and even death. The present study was undertaken to assess the difference in the retinal nerve fiber layer (RNFL) thickness in patients

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Table 1
Modified Frisen scale.

Papilledema grade	Clinical features
0 (Normal optic Disk)	Prominence of the retinal nerve fiber layer at the nasal, superior, and inferior poles in inverse proportion to disk diameter Radial nerve fiber layer striations, without tortuosity
1 (Minimal degree of edema)	C-shaped halo that is subtle and grayish with a temporal gap; obscures underlying retinal details Disruption of normal radial nerve fiber layer arrangement striations Temporal disk margin normal
2 (Low degree of edema)	Circumferential halos Elevation (nasal border) No major vessel obscuration
3 (Moderate degree of edema)	Obscuration of one segment of major blood vessels leaving disk Circumferential halo Elevation (all borders) Halo (irregular outer fringe with finger-like extensions)
4 (Marked degree of edema)	Total obscuration on the disk of a segment of a major blood vessel on The disk Elevation (whole nerve head, including the cup) Border obscuration (complete) Halo (complete)
5 (Severe degree of edema)	Obscuration of all vessels on the disk and leaving the disk

with papilledema and normal individuals using optical coherence tomography and to correlate the RNFL thickness with the degree of papilledema.

2. Methods

A case control study was conducted from August 2011 to July 2013 in a tertiary care postgraduate teaching medical institute of south India. Ethical clearance was obtained. All adult patients diagnosed or suspected to have papilledema were included in the study. Exclusion criteria included patients with pseudopapilledema, optic disk drusen, high hypermetropia and tilted disk, those with anterior ischemic optic neuropathy, glaucomatous cupping and those who had undergone previous retinal laser therapy. Age and sex matched individuals were included as controls. An informed consent was taken from all the patients.

Demographic data such as age, sex, primary diagnosis, duration of the illness was recorded. Visual complaints, if any, like diminution of vision, was recorded. Detailed ophthalmological examination included slit lamp biomicroscopic examination using +90D lens to examine the disk particularly for the presence of papilledema. Fundus photograph was taken for documentation. Disk photographs were graded according to modified Frisen criteria (Table 1). Best corrected visual acuity, color vision testing using the Ishihara's pseudo-isochromatic plates, central field charting, using the Humphrey field analyzer (Zeiss Humphrey Systems, Dublin, CA), with a white on white 24-2 SITA full threshold pattern was done. Retinoscopy under a mydriatic and cycloplegic drug was done. All cases were subjected to an ultrasound B scan to rule out disk drusen. Time domain (Stratus OCT; Carl Zeiss, Meditec, Dublin, CA) was used. Fast RNFL scan protocol was used to measure the thickness of peripapillary retina. A signal strength of 6 or more was taken as an acceptable scan. At least 3 scans were taken for each eye. The RNFL thickness parameters calculated by the Stratus-OCT software (version 4.0.1) were averaged for thickness in the temporal, superior, inferior and nasal quadrants. The controls also underwent detailed ophthalmological evaluation as cases.

Table 2
Age distribution.

Age group (years)	Cases	Controls
18–29	25	21
30–39	15	26
40–49	8	12
50–59	2	4
Total	50	63

3. Analysis

Age of the cases and controls was compared using an independent samples *t*-test. Retinal nerve fiber layer thicknesses in the four quadrants in peripapillary areas were compared using an independent samples *t*-test. Correlation between RNFL thickness and modified Frisen scale of papilledema was done using Spearman correlation. GraphPad InStat 3 version was used for statistical analysis.

4. Results

A total of 50 patients (100 eyes) and 63 controls (126 eyes) were included in the study. Age distribution of cases and controls is shown in Table 2.

Sex distribution was equal in both groups. The distribution of the primary illness among the cases is shown in Table 3. Majority of the patients had papilledema due to space occupying lesion as seen on neuroimaging or benign intracranial hypertension who underwent ventriculoperitoneal shunt surgery.

4.1. Visual acuity

Thirty six patients (72%) had best corrected visual acuity of 6/6 at presentation, twelve cases (24%) had visual acuity between 6/9 and 6/12 and two cases (4%) had a visual acuity of 6/18 and 6/24. There was no statistically significant difference between the cases and controls. The majority of patients did not have diminution of vision at presentation.

4.2. Grade of papilledema

Out of fifty patients, seventeen patients (34%) had grade 1 papilledema, nine patients (18%) grade 2 papilledema, thirteen patients (26%) grade 3 papilledema, six patients (12%) grade 4 papilledema and four patients (10%) grade 5 papilledema.

4.3. RNFL thickness in controls

The normal RNFL thickness was assessed in 126 eyes of 63 healthy controls. The inferior quadrant RNFL was the thickest with a measurement of $139 \pm 24\,\mu m$ followed by superior and nasal quadrant with a thickness of $137 \pm 28\,\mu m$ and $96 \pm 37\,\mu m$, respectively. The temporal RNFL was thinnest with a measurement of

Table 3
Distribution of cases.

Clinical diagnosis	Cases	%
Idiopathic intracranial hypertension	20	40
Intracranial space occupying lesion (ICSOL)	12	24
Obstructive hydrocephalus	8	16
Meningitis	7	14
Cerebral hemorrhage	3	6