*IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*
*e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 15, Issue 2 Ver. V (Feb. 2016), PP 16-22*
*www.iosrjournals.org*

# Correlation of Spectral Domain Optical Coherence Tomography Findings with Visual Acuity in Central Serous Chorioretinopathy

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***Abstract:***
***Purpose:*** *Evaluation of the structural changes of retina in acute central serous chorioretinopathy (CSCR) using spectral domain optical coherence tomography (SD-OCT) and correlation of these retinal changes with best corrected visual acuity (BCVA).*
***Study design:*** *Hospital based prospective study.*
***Study Period:*** *1 year*
***Setting:*** *Assam Medical College & Hospital*
***Methods****: All consecutive acute cases of CSCR within 9 months were examined and enrolled. They were divided into 4 groups according to BCVA (Best corrected visual acuity) at presentation. The 1st group was consisted of patients with normal visual acuity 6/6, 2nd group with VA better than 6/18, 3rd group: (<6/18-6/60) and 4th group: (<6/60-3/60).Eyes were reclassified 3 months after inclusion.*
*We examined outer nuclear layer (ONL) thickness, sub retinal fluid (SRF) height at fovea, the presence of sub retinal precipitates(fibrin) and pigment epithelial detachment (number and site).Statistical analysis was done to find out any association& correlationof the above mentioned retinal changes & BCVA.*
***Results:*** *Total 39 consecutive patients (total 43 eyes as 4 patients had bilateral involvement) were recruited. Mean±SD age was 35.10±6.58 year. Mean logMAR BCVA was 0.22±0.21 at presentation and 0.16± 0.21 logMAR unit 3 months later. Thin ONL was correlated (r = -0.437, p=0.004) with poor visual acuity at resolved stage. There was also significant correlation (r= 0.493, p= 0.0008) of poor BCVA with greater SRF height measured at fovea. Fibrin in SRF was seen in 53.5% cases. No association (p= 0.90) with presence of fibrin and BCVA was seen. No association with presence of PED and BCVA was seen.*
***Conclusions:*** *SD-OCT may offer a new approach to the staging and knowledge of CSCR, and may help in the understanding of the mechanism of the disease. Thin ONL & greater height of SRF were correlated with poor BCVA at resolved stage. PED, fibrin in SRF were not associated with poor BCVA. ONL thickness reduction in poor BCVA group may be due to persistent photoreceptor damage.*
***Key Words****: Spectral domain optical coherence tomography (SD-OCT), Central serous chorioretinopathy (CSCR), Outer Nuclear layer (ONL), Sub-retinal fluid (SRF) height, Pigment epithelial detachment (PED), Sub-retinal precipitates & fibrin.*

## I. Introduction

Central serous chorioretinopathy (CSCR) is characterized by an idiopathic circumscribed serous retinal detachment, usually confined to the central macula, caused by leakage of fluid through the retinal pigment epithelium (RPE).[1]

CSCR typically affects individuals in the 20-50 years age range. In older than 50 years CSCR does occur, but it is difficult to distinguish from age related macular degeneration[2]. It is the fourth most common retinopathy after age-related macular degeneration, diabetic retinopathy and retinal vein occlusions[3].

Acute symptomatic central serous chorioretinopathy defined as first episode of symptoms and duration of symptoms before treatment of ≤12 weeks.The majority of acute CSCR cases resolve spontaneously in 2–3 months, with VA returning to close to premorbid levels.[4-5]

A diagnosis of CSR is usually established by biomicroscopy and confirmed by FA (Fluorescein angiography). However, optical coherence tomography (OCT) can serve as a complementary diagnostic tool for FA while providing additional information on the presence of subretinal fluid, retinal thickening, and pigment epithelial detachments (PED)[6].

Optical coherence tomography (OCT) enables high-resolution evaluation of structures within the retina in vivo. OCT is an emerging technology for performing high-resolution cross-sectional imaging. OCT is analogous to ultrasound imaging, except that it uses light instead of sound. OCT can provide cross-sectional images of tissue structure on the micron scale in situ and in real time. OCT can function as a type of optical biopsy and is a powerful imaging technology[7-8].

SD-OCT has further allowed in-depth evaluation of the retinal layers, allowing for possible identification of the leakage points without angiography, establishment of the cause of persistent defective

vision, and possible prognostication in acute CSCR. OCT has contributed to our understanding of the importance of the outer aspect of the foveal photoreceptor layer in visual function in macular diseases, especially high-definition OCT that gives us extensive information regarding precise topographic and layer-specific localization of discrete morphological changes indicating the presence of sub-retinal pathologies or retinal maladjustment caused by the underlying pathology[9].

## II. Aims & Objectives

1. Evaluation of the structural changes of retina in acute central serous chorioretinopathy (CSCR) using spectral domain optical coherence tomography (SD-OCT)
2. Correlation of these retinal changes with best corrected visual acuity (BCVA).

## III. Method& Material

All newly diagnosed and established cases of acute CSCR were selected. Informed consent was obtained from each of the patients after explaining the purpose of the study.

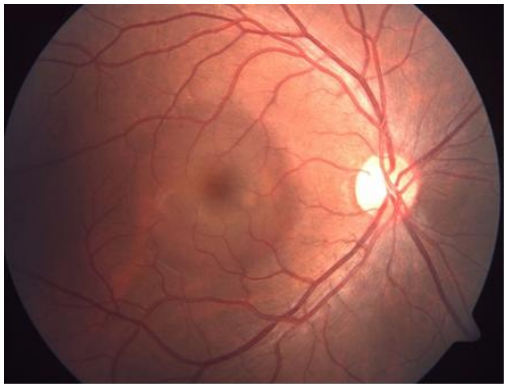
**Selection of Patients:**

| Inclusion Criteria: | Exclusion Criteria: |
|---|---|
| 1) Age group 20-50 years, both male and female patients.<br>2) Clinical fundus examination suggestive of acute central serous chorioretinopathy and confirmed by FFA. | 1) AGE <20 years and >50yrs.<br>2) Media opacity.<br>3) Fundus examination suggestive of retinal disorders like Proliferative and non-proliferative diabetic retinopathy, hypertensive retinopathy, choroidal neovascularisation, drusen etc.<br>4) Patient already undergone vitreoretinal surgery or laser photocoagulation. |

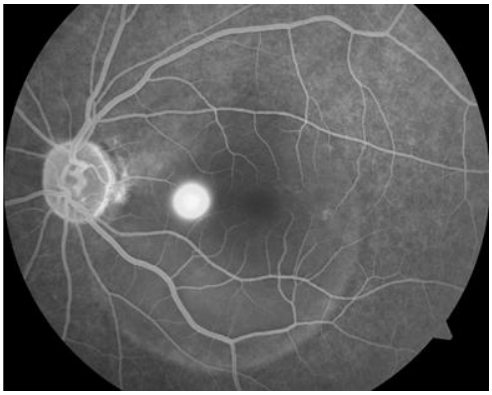
Acute CSCR was diagnosed based on the presence of a serous detachment of the neurosensory retina using biomicroscopy, focal dye leakage on FFA, and the duration of any recent subjective symptoms occurring within the preceding 3 months. Resolved CSCR was diagnosed based on the absence of SRF(Sub-retinal Fluid) and an active leak on angiography. FFA also excluded cases of suspicious occult choroidalneovascular membranes and polypoidal choroidal vasculopathy.

**Data Collection*:*** In this study all consecutive acute cases of CSCR within 9 months were examined and enrolled .They were divided into 4 groups according to BCVA (Best corrected visual acuity) at presentation. The 1st group was consisted of patients with normal visual acuity 6/6, 2nd group with mild or no visual impairment i.e. better than 6/18, 3rd group with moderate visual impairment i.e. (6/18-6/60) and 4th group with severe visual impairment (6/60-3/60). Treatment was not given to them except for placebo eye drops.CSCR usually resolves within 3 months. So, 3 months after inclusion, eyes were reclassified into three groups, based on the same VA criteria, and a repeat OCT was done to see changes in resolved phase.

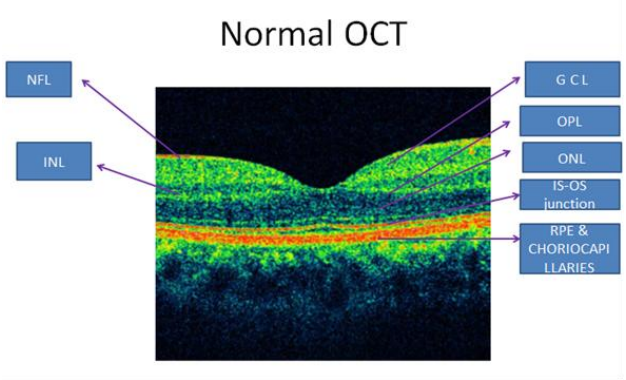
The present study examined the relevance of retinal Outer Nuclear layer (ONL) changes with best corrected visual acuity (BCVA). Outer nuclear layer is the distance between external limiting membrane and outer plexiform layer. The study also looked at whether certain tomographic features, such as subretinal fluid (SRF) height at fovea, the presence of sub retinal precipitates in the SRF ( fibrin) and pigment epithelial detachment (number and site), had any association with best corrected visual acuity.



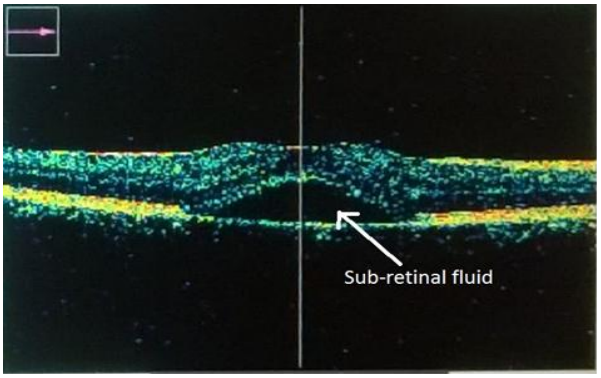
Fundus picture of CSCR with PED



FFA picture showing ink-blot leakage in a case of CSCR




Normal SD-OCT image of macula showing different layers




Separation of neurosensory retina from pigment epithelium & collection of fluid in CSCR

**Statistical Analysis*:*** All the obtained data were calculated in terms of mean, standard deviation (SD) and percentage (%).Significance of different variables were tested using ANOVA test, Fisher's exact test and correlation coefficient (r), whichever and wherever necessary. P value of (‹ 0.05) was considered statistically significant. SPSS 16.0 version software was used for calculation.

Ethical clearance was obtained from the institutional ethics committee of Assam Medical College and Hospital, prior to the commencement of the present study.

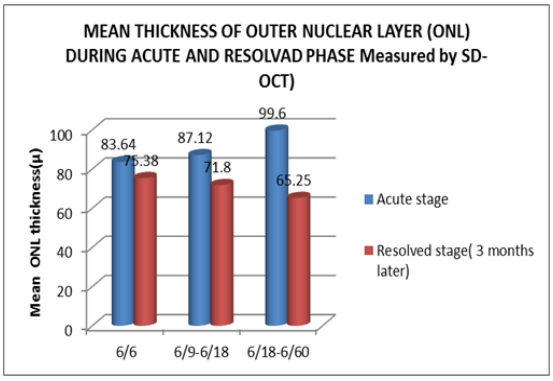
## IV. Results

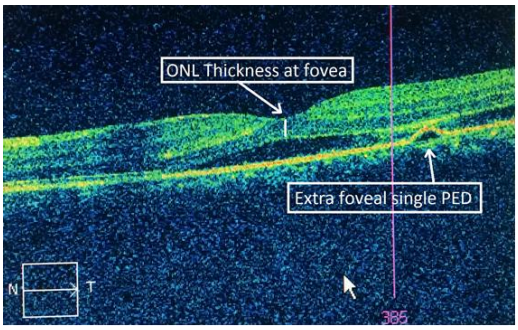
Mean age of all patients were 35.10 years and standard deviation (SD) was 6.58 years.Total 33 were males (84.6%) and female patients were 6 (15.4%) out of total 39 patients. The male and female ratio in this study group was (5.5:1).Bilateral involvement was seen in 4 patients 10.26%.

According to the best corrected visual acuity (BCVA) patients were divided in different groups. In this study 14 eyes (32.56%) after correction had 6/6 visual acuity. Maximum patients had a visual acuity of 6/9-6/18 (55.81%). Only 5 patients improved to ‹6/18-6/60 (11.63%).No patients had visual acuity poor than 6/60 after correction. So, we made 3 groups for the further calculation purpose. Mean logMAR visual acuity was (0.22±0.21) at first presentation and it was improved to0.16± 0.21after 3 months. Fundus fluorescein angiography 36 eyes (83.72%) showed typical ink-blot pattern of dye leakage and 7 eyes (16.28%) showed smoke-stack pattern.

**Table & graph: 1 According to mean thickness of outer nuclear layer (ONL) during acute and resolved phase**

| GROUPS | VISUAL ACUITY | Acute stage | | Resolved stage (3 months later) | | p-value |
|---|---|---|---|---|---|---|
| | | Mean ONL thickness (µm) | No. of eyes | Mean ONL thickness (µm) | No. of eyes | |
| 1 | 6/6 | 83.64±8.51 | 14 | 75.38±7.09 | 21 | 0.029 |
| 2 | 6/9-6/18 | 87.12±7.05 | 24 | 71.8± 7.27 | 15 | |
| 3 | 6/18-6/60 | 99.6±5.59 | 5 | 65.25± 4.79 | 4 | |



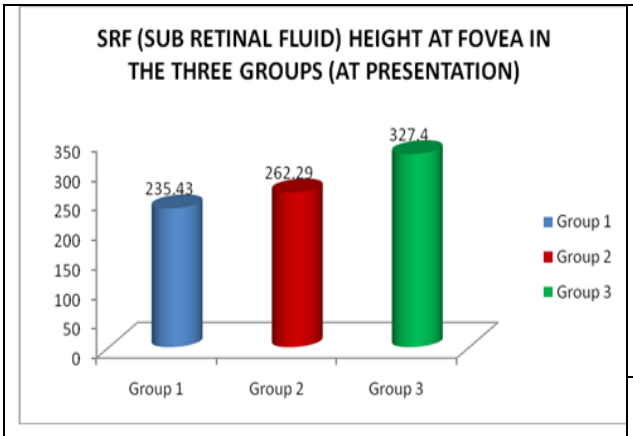



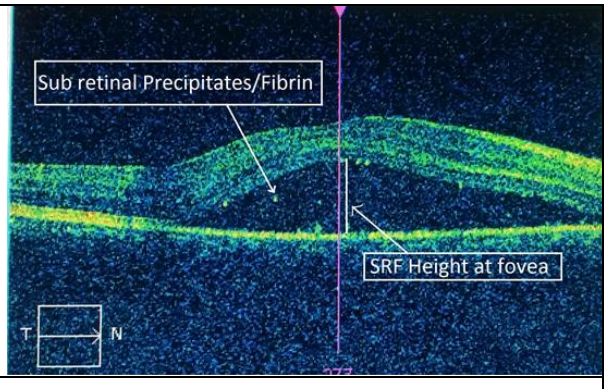

SD-OCT of macula showing the ONL thickness

In the first group (mean ± SD) ONL thickness at presentation was (83.64±8.51µm), and 3 months later it was (75.36±7.07µm). In group 2 (mean±SD) ONL thicknesses is (87.12±7.05µm) & at resolved stage it was (71.8±7.27µm). In group 3 (mean±SD) ONL thicknesses was (99.6±5.59 µm) and in resolved phase it was (65.25±4.79µm). The P-value was (0.029) in between 3 groups. So, there was a significant association between thin ONL and probability to be in poor visual acuity group in resolved stage of the disease. Correlation of ONL and BCVA at resolved stage (r = -0.437, p=0.004) was also significant and thin ONL correlated with poor visual acuity.

**Table & Graph: 2 According toSRF (sub retinal fluid) height at fovea in the three groups (at presentation).**

| **GROUPS** | **BCVA At presentation** | **No. of eyes** | **SRF HEIGHT(µm) Mean±SD** | **p-value** |
|---|---|---|---|---|
| 1 | 6/6 | 14 | 235.43±78.51 | 0.029 |
| 2 | 6/9-6/18 | 24 | 262.29±57.10 | |
| 3 | ‹6/18-6/60 | 5 | 327.4±41.17 | |
| Mean of all groups | | 43 | 261.12±67.81 | |



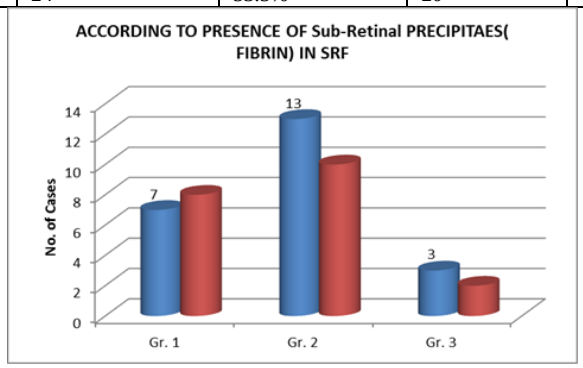




SD-OCT image of macula showing Sub-retinal precipitates & SRF height at fovea

The sub-retinal fluid height was measured by SD-OCT at the fovea. Mean height was calculated for each group. In the 1stgroup (mean±SD) height of SRF was (235.43±78.51µm), in the 2nd group the (mean±SD) height of SRF was (262.29±57.10 µm), and in the 3rdgroup (mean±SD) height of SRF was (327.4±41.17 µm). The mean of all the values was (261.12±67.81µm).There was significant association (P = 0.029) of greater height of SRF at fovea with poor visual acuity between 3 groups. There was also significant correlation (r= 0.493, p= 0.0008) of poor BCVA with greater SRF height.

**Table & Graph: 3: According to presence of sub-retinal precipitates (fibrin) in SRF**

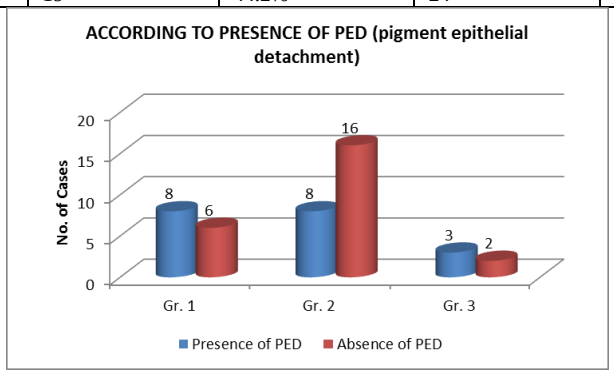
| Groups | BCVA | Presence of fibrin | percentage | Absence of fibrin | percentage | P-value |
|---|---|---|---|---|---|---|
| 1 | 6/6 | 7 | 16.3% | 8 | 18.6% | 0.90 |
| 2 | 6/9-6/18 | 13 | 30.2% | 10 | 23.3% | |
| 3 | ‹6/18-6/60 | 3 | 7% | 2 | 4.6% | |
| Total | | 24 | 53.5% | 20 | 46.5% | |




Total 23 eyes had fibrin in SRF (53.5%) and rest 20 eyes (46.5%) did not show any presence. The p value was 0.90; means there was no association with presence of fibrin and best corrected visual acuity.

**Table & Graph: 4 According to presence of PED (pigment epithelial detachment)**

| Groups | BCVA | No. of eyes with presence of PED | Percentage ( out of 43 eyes) | No. of eyes with absence of PED | Percentage ( out of 43 eyes) | p-value |
|---|---|---|---|---|---|---|
| 1 | 6/6 | 8 | 18.6% | 6 | 13.9% | 0.33 |
| 2 | 6/9-6/18 | 8 | 18.6% | 16 | 37.2% | |
| 3 | 6/18-6/60 | 3 | 7% | 2 | 4.7% | |
| Total | ---- | 19 | 44.2% | 24 | 55.8% | |




In this study we found PED in total 19 eyes out of 43. The percentage was 44.2%. Of which 8 eyes were belonged to the group 1, 8 eyes belonged to group 2 and rest 3 eyes were belonged to group 3. Eyes with PED in group 1, 2 and 3 were respectively 18.6%, 18.6% and 7% of cases.

Eyes with no PED was found in 55.8% of cases, of which 13.9%, 37.2% & 4.7% were respectively in group 1, 2, and 3.we calculated the p value. It was 0.33. So, there was no significant association with PED and BCVA.

Total 9 eyes (47.4%) had single PED and 10 eyes (52.6%) had multiple PED. No statistical association (P=0.84) was seen with number of PED and BCVA.Total 4 eyes (21%) were with sub-foveal PED and 15 eyes (79%) were with extra-foveal PED. P value was 0.45. So there was no associationwith site of PED and visual acuity.

## V. Discussion

Central serous chorioretinopathy (CSCR) is a major cause of vision threat among middle-aged male individuals. Multimodal imaging led to the description of a wide range of CSCR manifestations, and highlighted the contribution of the choroid and pigment epithelium in CSCR pathogenesis.

This study was done with 39 patients (43 eyes) of acute and first attack of CSCR. It was aimed to find out retinal changes by spectral domain optical coherence tomography (SD-OCT), and any relation of these changes with visual acuity.

The mean BCVA reported by other authors was 0.33±0.37 logMAR, 0.21±0.25 logMAR, 0.24±0.25 logMAR in studies done by Anna Elias et al[10], kim et al[11], Yalcinbayir et al[12] respectively. About the fluorescein dye leakage ink-blot pattern was seen in 71.4% cases by Castro-Correia J et al[13],80% ink-blot pattern seen by Alicia CSW How et al[14],88.13% ink-blot pattern was found by Tariq Qureshi et al[15].Bujarboruaet al[16] found smoke-stack leak in 14.40% of acute cases.

- Hidetaka Matsumo et al[17] found the average ONL thickness at the central fovea was significantly (P < .001) thinner the ONL thickness was correlated with the BCVA (P < .001).Nair U et al[18], reported the mean outer nuclear layer thickness during the active stage was 95.10 µm and during the resolved stage, it was 77.69 µm. The Outer Nuclear Layer thickness and the visual acuity found to be statistically significant (P=0.012), and hence there was an association between a thin ONL layer and poor visual acuity in resolved stage. Ozdemir O et al[19] also mentioned in a study the ONL thickness was correlated with the BCVA ($r = 0.681$, $p = 0.001$))
- Soh-Eun Ahn et al[20], mentioned, the mean peak height of SRF in acute CSC was (298.13 ± 92.67 µm) whereas J A Montero et al[21], mentioned mean±SD height was (198 ±107µm). Maalej A et al[22] found poor initial visual acuity and greater subretinal fluid height (p=0.054) has a significant correlation & Nair U et al[18]reported mean SRF height was 279.11 ±148.78 µm (mean±SD) & association between the various dimensions and height of the SRF and BCVA was significant (p = 0.030 for Height of SRF).
  Dot-like precipitates and subretinal yellow materials were seen in 65% of the eyes by Maruko et al[23] and 61% case byNair U et al[18]. A hyper-reflective shadow suggesting fibrin in the subretinal space was observed around the leakage point in 52% cases by Fujimoto et al[24]. Most dot-like precipitates and subretinal yellow material had highly reflective tissue in the subretinal space on OCT[18].
- Pigment epithelial detachment (PED) was seen in 36% eyes by Hirami et al[25], but Hisataka Fujimoto et al[24] and Mitarai K et al[26] found it in 61% and 63% cases.Nair U et al[18], in their study reported single pigment epithelial detachment (PED) and multiple PEDs were seen in 21% and 49% of cases respectively. They also had reported PED did not have any association with poor VA. But Mudvari SS et al[27]mentionedPEDs were commonly extra-foveal (82%) and sub-foveal PED occurred less commonly and might associated with poorer visual prognosis.

## VI. Conclusion

SD-OCT has brought an old disease in new light with different characteristic retinal findings. It helps to measure the thickness of retinal layers and other pathologies like PED, precipitates in SRF. It can also monitor the diseased condition and helps us to understand the progress of the disease.

OCT may offer a new approach to the staging and knowledge of CSCR, and may help in the understanding of the mechanism of the disease. Persistent thin ONL in patients with poor visual acuity may be due to photoreceptor damage. A suggestion can be made that serial measurements of the ONL may contribute to decide any intervention in the form of laser or photodynamic therapy to prevent visual loss following CSCR**.**

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