

Morphological features of focal choroidal excavation and its association with macular pathology in Asian Indian eyes

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Purpose: To study the characteristics of focal choroidal excavation (FCE) in Indian eyes based on spectral-domain optical coherence tomography (SD-OCT) findings and their association with macular pathologies. **Methods:** Retrospective study of 26 patients diagnosed with FCE. All patients' clinical and imaging data were reviewed. **Results:** There were eight females and 18 males aged between 24 and 85 years. FCE was noted in 31 eyes of 26 patients – unilateral in 21 and bilateral in 5. The conforming type was noted in 13 and nonconforming in 19 eyes. The location was extrafoveal in 16 and subfoveal in 15 eyes. The morphology was bowl-shaped in 24, cone-shaped in six eyes, and mixed type in one eye. Associated pathologies were central serous chorioretinopathy in nine eyes, choroidal neovascular membrane in seven eyes, Stargardt's disease in three eyes, Best disease in four eyes, other retinal dystrophies in two eyes, polypoidal choroidal vasculopathy and moderate non-proliferative diabetic retinopathy, each in one eye. The mean FCE width was $1667.2 \pm 817.7 \mu$, mean depth was $95.7 \pm 46.4 \mu$, and the mean choroidal thickness under the FCE was $234.8 \pm 85.9 \mu$. No abnormal choroidal tissue was found under any FCE. **Conclusion:** FCE is a relatively common entity and frequently associated with macular pathologies. The presence of an FCE did not alter the course or management of these conditions.

Key words: Bowl shape, cone shape, conforming, focal choroidal excavation, nonconforming

Focal choroidal excavation (FCE) is defined as an area of choroidal excavation without evidence of a posterior staphyloma or scleral ectasia, detected on spectral-domain optical coherence tomography (SD-OCT). It is not associated with a history of trauma, posterior uveitis, retinal or choroidal vascular disease, or prior retinal or choroidal infection. It is local idiopathic cupping of the choroid which is usually unilateral, with good visual acuity and minimal or no change over time.^[1] In 2006, Jampol *et al.*^[2] first identified this lesion in an asymptomatic patient on optical coherence tomography (OCT) and later Margolis *et al.*^[3] used the term FCE for areas of choroidal pitting observed in the macula in patients without a posterior staphyloma or scleral ectasia.

In most patients, the presence of FCE is not evident on routine clinical examination. It is more evident on SD-OCT and can be either "conforming" when the retinal pigment epithelium (RPE) follows the contours of the photoreceptor layer or "nonconforming" if photoreceptors are detached from the RPE.^[3-5] Several studies have documented the association of FCE with choroidal vascular disorders including central serous chorioretinopathy (CSCR), choroidal neovascularization (CNV), and polypoidal choroidal vasculopathy (PCV), which are primarily responsible for the visual symptoms.^[6-8] While there is literature on the characteristics of FCE in those of

Southeast Asian ethnicity, there are no large studies on FCE in Indians.^[1,9] Hence, the purpose of this study is to describe the characteristics of FCE in Asian Indian eyes and their association with macular pathologies based on SD-OCT findings.

Methods

This was a retrospective, observational study conducted at the vitreoretinal department of a tertiary care eye hospital. The study was approved by the Institute Ethics Committee and the Institute Research Board and adhered to the tenets of the Declaration of Helsinki. The single selection criterion for enrolment into the study was an FCE detected on the SD-OCT scan between January 2010 and January 2018. An FCE was defined as an excavated area in the choroid, along with the RPE/Bruch's membrane complex on the scan.^[10] Patients with pathological myopia, angioid streaks, active intraocular inflammation, prior ocular trauma, macular laser photocoagulation, photodynamic therapy, and prior vitreoretinal surgery were excluded as they affect the morphology of the outer retina and choroid. A total of 26 patients were identified and their clinical data which included demographics, visual acuity, clinical findings, imaging details

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which included SD-OCT, fundus autofluorescence (FAF), fundus fluorescein angiography (FFA), indocyanine green angiography (ICGA), OCT angiography (OCTA, when available), and treatment modalities, if any, were recorded.

SD-OCT imaging and FCE measurements

Vertical, horizontal, and radial scans through the fovea were acquired using the Heidelberg Retinal Angiography and OCT System (Spectralis Heidelberg Engineering). Enhanced depth imaging (EDI) OCT scans were also done for some patients. Measurements of the various dimensions of the FCEs were performed using the built-in caliper feature of the device. The greatest linear diameter (GLD) of the FCE in microns was measured as the maximal horizontal distance between the two points where the RPE layer dipped, using a cross-sectional line scan directly across the FCE.^[1] Depth was measured from the line measuring the GLD to the outer border of the lowest depression of the excavated RPE layer. Choroidal thickness in microns under the excavation was measured from the outer border of the lowest depression of the excavated RPE layer to the inner scleral surface on the EDI scan.

The location of the FCE was categorized as subfoveal or extrafoveal (defined as the distance between the posterior border of the FCE and the foveal center being greater than 200 μm). They were also classified based on the shape into cone-type [Fig. 1a], bowl-type [Fig. 1b], or mixed type.^[11] “Nonconforming type” FCE [Fig. 1c] had a space between the photoreceptor tips and the RPE and the “conforming type” [Fig. 1d] has no separation.^[11,5] In whom the FAF, FFA, and ICGA were done, the findings were analyzed. The OCTA was available for only one patient. The diagnosis of associated macular pathologies was made based on clinical evaluation, SD-OCT, and angiography.

Statistical analysis

All statistical tests were performed with GraphPad Prism software (Version 8.1.1). Results of descriptive analysis for quantitative variables were expressed as the mean with standard deviation, while categorical variables were expressed

as a number and percentage. A comparison between the groups was done using the *t*-test. Pearson’s coefficient was used to assess the correlation between the size of the FCE and the choroidal thickness. For all analyses, a *P* value <0.05 was considered statistically significant.

Results

Baseline demographics

There were 31 eyes of 26 [Table 1] patients with FCE on SD-OCT. All patients were of Asian Indian ethnicity. The age group of our cohort ranged from 24 to 85 years. Most (46.6%) of them belonged to the 50–68 years age group and 69.2% were males. Unilateral involvement was seen in 81%, with a right eye preponderance (66.6%).

OCT analysis

A total of 15 (48.38%) eyes had a subfoveal FCE and the remaining 16 (51.61%) had an extrafoveal FCE. One of the patients had two FCEs in one eye. Based on morphology, 19 FCEs were non-conforming and 13 were conforming type. Bowl-shaped FCE was seen in 24 eyes (77.41%), cone-shaped in 6 eyes (19.35%), and mixed type in 1 eye (3.2%). The mean GLD was 1667.2 ± 817.7 μ and the mean depth was 95.7 ± 46.4 μ. The mean choroidal thickness under the FCE was 234.8 ± 85.9 μ. There was no statistical difference in the GLD of FCE with and without associated macular pathologies (*P* = 0.21). No significant correlation was found between the size of the FCE, as measured by GLD and FCE depth, and the choroidal thickness under the excavation (*P* = 0.91, *P* = 0.2).

Associated macular pathology

In our study, 27 (87.09%) eyes had a concurrent macular pathology [Fig. 2]. Nine eyes of nine patients (34.6%) had a CSCR [Fig. 3a], choroidal neovascular membrane (CNVM) was seen in seven eyes of seven patients (26.9%, Fig. 3b), and Stargardt’s disease in two patients (7.69%, Fig. 3c), of which one patient had FCE in both eyes. Two patients (7.6%) had Best disease [Fig. 3d] and both had bilateral FCE. One patient had rod-cone dystrophy and another had cone-rod dystrophy. One patient had a PCV [Fig. 3f] with a branching vascular network and one had moderate non-proliferative diabetic retinopathy. In 23 eyes, the FCE was located within the area of associated macular pathology and in 4 eyes, away from the associated macular pathology. There was no statistically

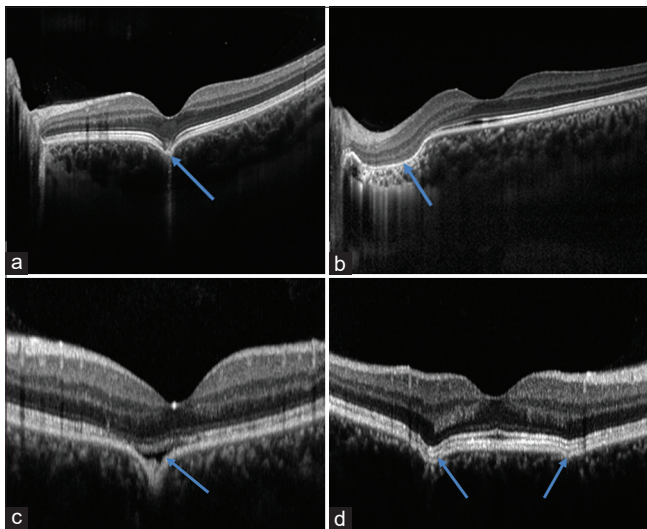


Figure 1: Spectral-domain optical coherence tomography showing a cone-shaped focal choroidal excavation (FCE; a), bowl-shaped FCE (b), non-conforming FCE (c) and conforming FCE (d)

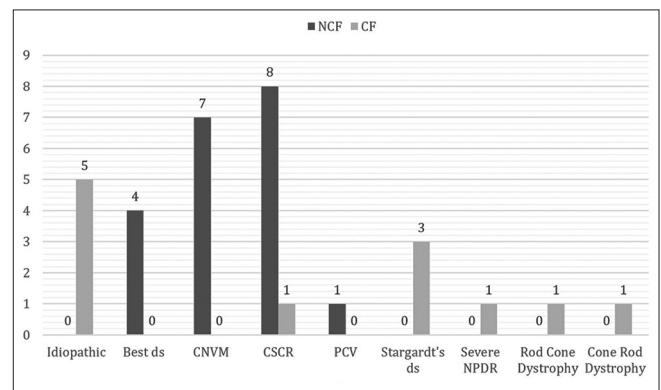


Figure 2: A chart showing the distribution of various macular pathologies in eyes with a focal choroidal excavation. (NCF: Non-conforming, CF: Conforming)

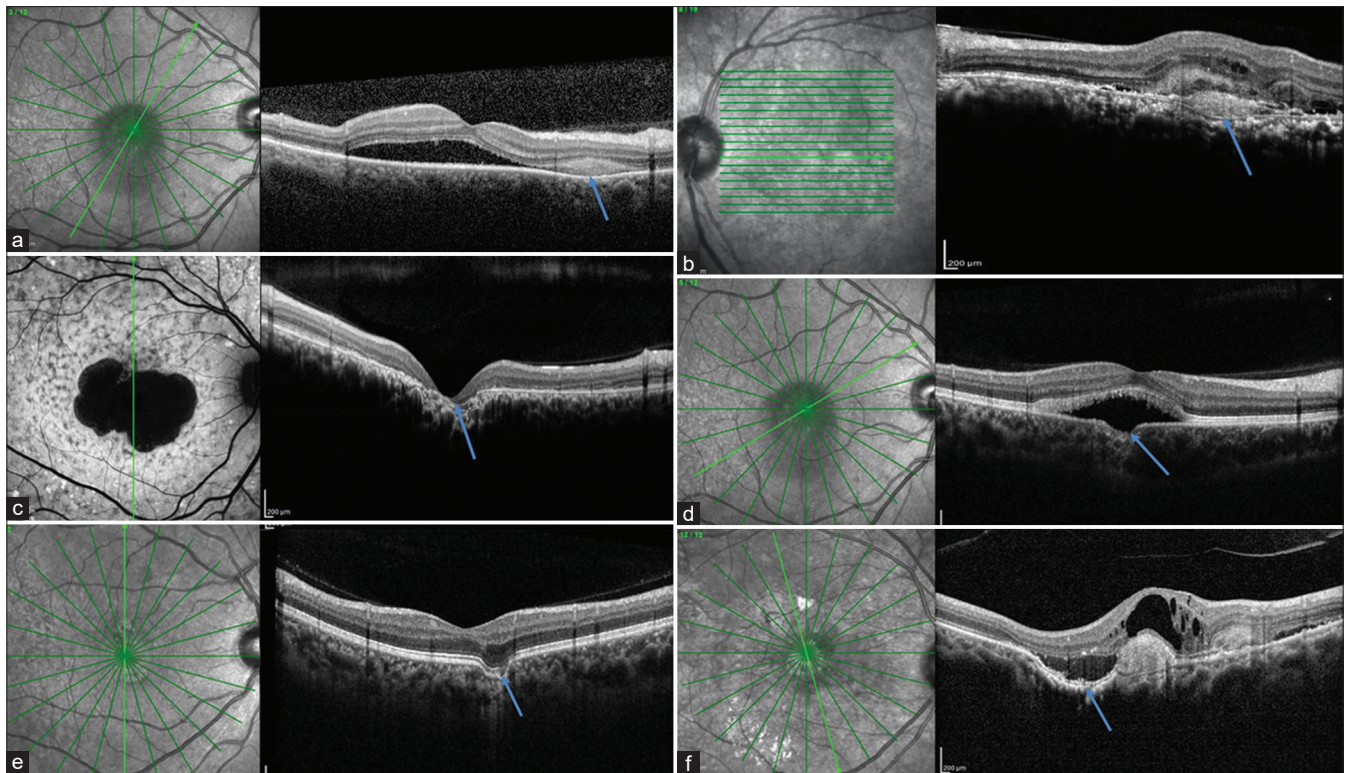


Figure 3: Spectral-domain optical coherence tomography showing a focal choroidal excavation (FCE; blue arrow) in a case of central serous chorioretinopathy with neurosensory detachment (a), choroidal neovascular membrane (b), Stargardt's disease with macular atrophy (c), Best disease (d), idiopathic (e), polypoidal choroidal vasculopathy (f)

significant correlation between the morphological type of FCE and macular pathology.

Other imaging modalities

Fundus autofluorescence was available for 19 eyes and hypoautofluorescence was seen in 17 eyes and two eyes showed hyperautofluorescence in the region of FCE. In the 11 eyes for whom the FFA was done, leakage was seen in eight eyes, a window defect was seen in two eyes, and pinpoint hyperfluorescence was seen in one eye in the region of FCE. Four eyes with ICGA showed abnormalities consistent with the primary macular pathology. One eye with OCTA done showed FAZ abnormalities secondary to chronic CSCR.

Clinical course

There were eight (30.7%) patients who had a follow-up of more than 24 months. Three patients had a CNVM secondary to age-related macular degeneration, of which two patients had worsening of vision. Three patients had CSCR, all of whom showed resolution of subretinal fluid without any intervention and one patient developed a recurrence which self-resolved. Two patients of Best disease and Stargardt's disease did not show any change in the follow-up. Two patients had an idiopathic CNVM, of which one patient showed resolution of fluid after receiving an intravitreal anti-vascular endothelial growth factor (anti-VEGF) injection and the other patient did not come for follow-up. In two eyes with CNVM, non-conforming FCE converted into conforming after treatment of the underlying pathology – one eye showed complete resolution of intraretinal and subretinal fluid and regression of CNVM after taking 3 monthly intravitreal injections of anti-VEGF with improvement in vision.

Table 1: Demographic details of eyes diagnosed to have a focal choroidal excavation

Age (years)	Number (%)
Mean	48.03
Median	50.5
Range	24-85
Sex	
Male	18 (69.2)
Female	8 (30.8)
Laterality	
Right eye	14 (66.66)
Left eye	7 (33.33)
Unilateral	21 (80.78)
Bilateral	5 (19.24)

Discussion

This is a study of FCE diagnosed on SD-OCT in 26 Asian Indian patients over an 8-year study period. The mean age of the patients was 50.5 years and ranged from 24 to 85 years, similar to existing literature.^[1,12] We found it to be more common in males which is in contrast to what has been seen in people of South Asian ethnicity where no gender predilection was found.^[4,13] While we saw FCE more in the right eye (57.14%), Chung *et al.*^[13] found it to be more common in the left eye. It has been speculated that traction may be a potential factor in the formation of different morphologies of FCE.^[13] However, the non-conforming FCE, seen in two-thirds of our patients,

Table 2: Comparison of the characteristics of focal choroidal excavation across different case series

	Current study	Chung <i>et al.</i> ^[13]	Kobayashie <i>et al.</i> ^[14]	Ellabban <i>et al.</i> ^[10]	Suzuki <i>et al.</i> ^[7]
GLD μ m	1676.9 \pm 826.5	636.25 \pm 265.11	757 \pm 494	670.8 \pm 386.3	828.4 \pm 338.4
CT μ m	192.3 \pm 74.5	183.63 \pm 52.39	172 \pm 116	N/A	176.4 \pm 78.6

was not associated with any traction. The mean GLD of the FCE in this study was 1676.9 μ ; larger compared to those already reported in the literature [Table 2]. Chung *et al.* found the mean size of the FCE to be significantly larger in eyes with concurrent macular pathology, while we found no such correlation.^[13] We found the FCE to be extra-foveal in a majority of cases (63.63%) which was similar to studies done by Chung *et al.*,^[13] Lim *et al.*^[15] and Ellabban *et al.*^[10] In contrast, Lee *et al.*^[1] and Yao Wang *et al.* found the sub-foveal FCE to be more common than the extrafoveal FCE.^[9] While the bowl-shaped FCE (81.81%) was most common in our study, Shinjima *et al.*^[11] found the cone-shaped morphology to be more common.

Fundus autofluorescence done in 20 eyes showed hypoa autofluorescence in 18 eyes in the region of the FCE, reflecting RPE atrophy. Two eyes showed hyperautofluorescence, which was attributed to the associated macular pathology, i.e., leakage in CSCR and vitelliform deposits in the Best disease. Leakage seen in five of 11 eyes with FFA images was due to the associated macular pathology. No abnormal choroidal tissue was found under the FCE in any of the eyes in this study in contrast to Lim *et al.*^[15] who found unusual choroidal tissue in all study eyes. Yao Wang *et al.*^[9] found hyperreflective choroidal tissue under the FCE in some eyes, which caused inward pulling off the outer choroidal boundary.

A limitation of this study is its retrospective nature and limited follow-up. Prospective longitudinal studies will throw light on the importance of FCE and its possible role in the etiopathogenesis of associated macular pathologies.

Conclusion

This study is the largest series of FCE in Asian Indian eyes. We describe the morphology and association with macular pathology. However, the presence of FCE did not alter the course or management of these conditions.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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