RESEARCH ARTICLE

Prevalence of polypoidal choroidal vasculopathy in Indian population: Risk factors, clinical and imaging characteristics

Meenakshi Kumar1, Sangeetha E. Moptom2, Parveen Sen1, Vikas Khetan1, Muna Bhende1, Sobha Sivaprasad3, Rajiv Raman1*, on behalf of Sankara Nethralaya Vitreoretinal Study Group (SNVR-Study Group)¶

1 Shri Bhagwan Mahavir Vitreoretinal Services, Sankara Nethralaya, Chennai, India, 2 Sankara Nethralaya Diabetic Retinopathy project, Chennai, India, 3 NIHR Moorfields Biomedical Research Centre, London, United Kingdom

¶ Membership of the Sankara Nethralaya Vitreoretinal Study Group (SNVR-Study Group, The complete list of authors of this group can be found in the Acknowledgments.)
* rajvpgtran@gmail.com

Abstract

Aim
To assess prevalence, clinical presentation and multimodal imaging characteristics of polypoidal choroidal vasculopathy (PCV) in a hospital-based setting in South India.

Methods
Electronic medical records (EMR) of new patients presenting with suspected clinical signs of wet age-related macular degeneration (AMD) in a tertiary hospital from January to December 2016 were retrospectively analyzed using keywords and filtered for patient who underwent multimodal imaging. Clinical presentations were categorized into predominantly hemorrhagic, exudative or mixed pattern. The imaging features were compared in these clinical groups. The multimodal images were graded by two masked graders and discrepancies between them were settled by a senior arbitrator.

Results
Of the 147 clinically suspicious cases of PCV out of 785 patients with clinical presentation of AMD as recorded in the EMR, 73 (49.7%) patients had a multimodal imaging diagnosis of PCV. There was no difference in the demography, distribution of polyps, ICGA and OCT characteristics in eyes presenting with hemorrhagic, exudative or mixed clinical features.

Conclusion
Approximately half of South Asian patients presenting with clinical features of neovascular AMD harbor PCV irrespective of their clinical presentation and so we recommend that multimodal imaging is done in all cases of suspicious neovascular AMD in Indian population.
Introduction

In contrast to epidemiological studies on age related macular degeneration (AMD), there are very few studies on population-based data on polypoidal choroidal vasculopathy (PCV) due to the inherent difficulty of diagnosing the disease from fundus photographs alone [1]. Thus, the estimates of PCV prevalence can only be accurately derived from hospital based cross-sectional studies. These studies have shown a prevalence of 4% [2] to 54% [3] depending on the inclusion criteria, imaging modality and ethnic origin of the population. The prevalence of PCV is known to be higher in Afro-Caribbean cohort and Eastern Asia population and low in the white race [4].

Although PCV has characteristic optical coherence tomography (OCT) features, indocyanine green angiography (ICGA) remains the definitive diagnostic imaging modality for PCV [5]. We have previously reported the prevalence of early or intermediate AMD to be ~21% in the rural Indian population and ~16% in the urban Indian population aged 60 years or more based on color fundus photographs. Likewise, the prevalence of neovascular AMD is ~2% in the same rural and urban Indian populations [6]. However, ICGA was not done in any population-based studies from India and so the prevalence of PCV in India is unclear. The aim of the study was to elucidate the prevalence, demography, risk factors and imaging characteristics of PCV in a hospital-based South Indian population presenting with characteristic features of neovascular AMD.

Methods

All patients aged 40 years or above who presented with presumed neovascular AMD to the Vitreoretinal services of a tertiary eye care center in South India from January to December 2016 were reviewed from the electronic medical records (EMR). Institutional review board approval (Ethics Committee, Vision Research Foundation) was obtained for this retrospective study. It is the hospital protocol to obtain informed consent form before any procedure including invasive procedure such as ICGA and FFA. The informed consent includes the information on how data will be used for scientific research and will be anonymized. The EMR was searched using the following keywords that defined the presenting diagnosis: choroidal neovascular membrane, wet age-related macular degeneration, hemorrhagic pigment endothelial detachment, polyps and ICD coding for polypoidal choroidal vasculopathy. All these entities represent the spectrum of serosanguinous maculopathy. Those with clinical suspicion of PCV, that is presence of subretinal exudation, subretinal hemorrhage, presence of pigment epithelial detachment, serous neurosensory detachment, peripapillary location, multiple lesions and visible polyps, underwent multimodal imaging. Multimodal imaging included color fundus photograph (Visupac, Version 4.4.3, Carl Zeiss Meditec.), fundus fluorescein angiography (FFA), ICGA (HRA system; Heidelberg Engineering, Heidelberg, Germany and visupac, Version 4.4.3, Carl Zeiss Meditec) and OCT (Cirrus OCT-Carl Zeiss Meditec, Dublin, CA, USA, Spectralis OCT- HRA system; Heidelberg Engineering, Heidelberg, Germany, Swept Source OCT–3D Optical Coherence tomography: DRI OCT-1 Atlantis, Topcon 3D OCT 2000-‘Toyko, Japan.). The extracted images were deidentified.

Clinical presentations of PCV

The clinical presentations were graded as (1) predominantly hemorrhagic pattern defined as presence of hemorrhagic pigment epithelial detachment (PED), submacular hemorrhage and multiple layers of hemorrhage, or (2) exudative pattern defined as the presence of exudates with serous or serosanguinous PED and/or subretinal fluid or (3) mixed lesions defined as the presence of both hemorrhagic and exudative features.
Multimodal imaging diagnosis of PCV

The diagnosis of PCV on colour photographs FFA and ICGA were confirmed based on the EVEREST criteria [7] that included the presence of early sub-retinal focal hyperfluorescence on ICGA (within the first 6 min), and at least one of the following criteria: (1) nodular appearance of the polyp(s) on stereoscopic examination, (2) hypofluorescent halo around the nodule(s), (3) presence of a branching vascular network (BVN), (4) pulsation of the polyp(s) on dynamic ICGA, (5) orange sub-retinal nodules on color fundus photography that corresponded to the ICGA nodules, or (6) massive sub-macular hemorrhage (>4 disc areas in size). Definitive polyp was defined as the presence of aneurysmal dilation clearly demarked in ICGA as minute hyperfluorescence. When the appearance of minute hyperfluorescence or aneurysmal dilation was masked due to hemorrhage or media haze and there was diffuse hyperfluorescence suggestive of an underlying polyp, the term suspicious polyp was used. Choroidal neovascularization (CNVM) due to AMD was diagnosed if the lesion showed presence of sub-retinal hemorrhage, subretinal fluid and retinal pigment epithelium (RPE) alterations with occult, ill-defined choroidal neovascularization lesion on FFA and early hyperfluorescence spots or plaque like hyperfluorescence in ICGA along with the absence of polyp and abnormal branching vascular network. Likewise, those who had features of different stages of retinal angiomatosus proliferans (RAP) as described by Yannuzzi et al [8] were also excluded.

Specific lesion characteristics of PCV

OCT and ICGA features of lesion characteristics were further defined as described as in the report by Anantharaman et al [9] and is shown in Fig 1. BVN (Branching vascular network) was defined on early phase of the ICGA (first 1 min) as a distinct network of vessels within the choroid termed as branching vascular network. Polyp was defined as small hyperfluorescent spots, isolated or in clusters that become visible soon after the PCV network is discernible on the ICGA. Early nodular hyperfluorescence arising from choroidal circulation noted within the first 6 min of dye injection were termed polyp. The polyps also leak slowly as the surrounding hitherto hypofluorescent area becomes increasingly hyper-fluorescence. Choroidal hyperpermeability was defined on mid phase ICGA as multiple and patchy choroidal hyperfluorescence.

**Speckled hyperfluorescence.** Mid phase multiple and patchy choroidal hyperfluorescence, indicating choroidal hyperpermeability.

Late-onset focal hyperfluorescent lesion with clear margin apparent with rosette pattern after at least 6 minutes phase of ICGA was termed as hyperfluorescence foci. OCT characteristics included peak-like PED defined as a sharp peak like elevation seen in PED with underlying moderate reflectivity. A tomographic notch was defined as a V-shaped dip between two PED and a double layer sign (DLS) was defined as a separation of RPE layer from underlying Bruch’s membrane containing neovascular complex.

Accuracy of grading

The extracted images were deidentified and were assessed by 2 senior retina specialists (with more than 10 years retinal experience) independently in a masked manner. An adjudicated grade by a third senior retina specialist was considered as a final diagnosis in cases where the diagnosis differed between the two retina specialists.

Statistical analysis

Statistical analysis was performed using statistical software (SPSS for windows, Version 20, SPSS science, IBM, Chicago, Illinois, USA). The results were expressed in frequencies for
categorical data and percentage for continuous data. Chi square test was done to compare proportions in PCV and CNVM group. RAPs were excluded from comparative analysis due to the small numbers. Univariate logistic regression analysis was performed to assess risk factors for PCV. Kappa statistics was done to report intergrader agreement.

Fig 1. Definitions used in the classification of features.

https://doi.org/10.1371/journal.pone.0231901.g001

Figure 1. (A) Shows speckled hyperfluorescence, (B) white arrow shows the abnormal network and black arrow is pointing polyp, (C) shows hyperreflective foci, (D) the first arrow shows the peak elevation in Pigment epithelial Detachment and second arrow below RPE layer points towards Double layer sign in Optical Coherence Tomography and (E) shows notch in Pigment Epithelial Detachment.
Results

Of the 785 records that matched with the keywords searched, 147 patients underwent multimodal imaging due to clinical suspicion of PCV. The proportions of patients with PCV, CNVM and RAP based on clinical presentations are shown in Fig 2. The prevalence of PCV among serosanguinous maculopathy was found to be 49.7% (Fig 2). The overall prevalence of PCV was 9.29%. The kappa agreement between the graders was $k = 0.632$ ($p = 0.001$).

Table 1 shows the demographic, systemic and ocular features of PCV. The prevalence of PCV increased with increasing age with a maximum (38.4%) in 70–80 years age group. PCV showed a unilateral preponderance (82.2%) and the majority were located in the macula (64.4%). The clinical presentation included hemorrhagic (52.1%), followed by exudative (34.25%) and mixed (13.70%). History of hypertension, ischemic heart disease were less prevalent in PCV.

Table 2 shows the univariate and multivariate analysis of risk factors for PCV. No statistical significance was achieved.

52.10% of PCV patients presented with hemorrhagic pattern, 34.25% showed exudative and 13.70% were of mixed subtype. Fig 3 shows the frequency of clinical findings present on fundus photographs. Most common feature was the presence of subretinal hemorrhage (71.2%) followed by PED (37%). Definitive clinically polyp was visible in 9.6% cases and suspicious polyps were present in 10.9% cases. No pulsation of polyp was observed in these cases.

Table 3 shows the FFA and ICGA features of patients with PCV. The presence of BVN was noted in 58% of the PCV patients and it was maximum in hemorrhagic type of PCV. However statistically significant differences in the presence of BVN were not observed in the three types of PCV. Polyps were single in 34.3% cases, multiple in 39.7% and in cluster in 17.8% cases. The occurrence of speckled hyperfluorescence was seen in 54.8% cases, however it was not statistically significant across the groups. The presence of hyperfluorescent foci was noted only in 17.8% of the PCV cases.

Table 4 shows the OCT characteristics of PCV across the three subtypes. Peaked PED was seen in 67.1%, tomographic notch in 68.5%- and double-layer sign in 61.6% of the cases. There

---

*Key words:* CNVM, Wet ARMD, Sub Retinal Hemorrhage, Hemorrhagic PED, Polyps and ICD coding- Polypoidal Choroidal Vasculopathy (n=785)

**Fig 2.** Flow of patient search and grading process.

[note: Figure not included in text, please refer to the PDF for visual aid]
were no statistically significant differences in the distribution of these features in the clinical subtypes of PCV.

**Discussion**

We report the prevalence of clinical and imaging characteristics of PCV in an Indian population seen within a tertiary center in South India. The prevalence of PCV among patients with serosanguinous maculopathy was found to be 49.7%, overall prevalence being 9.29% and is comparable to other clinic-based population studies conducted in Asia and Europe population.

Table 5 shows the summary of hospital and population-based studies across different population. Similar to our study, majority of the studies are hospital-based studies. The
prevalence of PCV is lower in studies from US [5] and Europe [2,10,11] compared to studies from Asia. [4,12–15,16] It is unknown why such ethnic variation exists in the epidemiology of PCV. Although a genetic predisposition may explain racial differences [17], it is unclear why the deeper choroidal vessels are more affected in Asian and Afrocarribean populations compared to the choriocapillaris in the white races. Further studies on differences in scleral resistance, vortex vein and choroidal vasculature may provide clues to explain these differences.

We found no difference in gender predilection between PCV and CNVM, similar to that reported by Yannuzzi et al [5] and Scassellati–sforzolini et al [10]. Previous reports indicate that PCV is more prevalent in men in Asian populations (22–37% female), but the opposite is observed in Caucasians (52–65% female). Differences in disease characterization and study design may explain our observation.

Surprisingly, we did not find a significant association of hypertension in PCV compared to CNVM group. The first literature is black ladies with hypertension [22]. However, subsequent literature is conflicting. Ahuja et al [23] reported that 2.90% of their series had diabetes and 23.5% had a history of hypertension. Ladas et al [19] reported, 36.4% patients had a history of hypertension. Byeon et al [15] and Sho et al [12] in their series found that 31.65% and 36% had

| Variable                  | Univariate |                  | Multivariate |                  |
|--------------------------|------------|------------------|--------------|------------------|
|                          | OR(95% CI) | P               | OR(95% CI)   | p               |
| Gender                   | 1.59(0.810–3.038) | 0.18          | 1.59(0.812–3.11) | 0.174          |
| H/o Diabetic mellites    | 1.51(0.769–2.991) | 0.229         | 1.44(0.695–2.995) | 0.325          |
| H/o Hypertension         | 1.31(0.687–2.52)  | 0.408         | 1.198(0.608–2.364) | 0.601          |
| H/o Ischemic heart disease | 1.00(0.873–2.683) | 1             | 0.899(0.320–2.528) | 0.84           |
| H/o Hypercholesterolemia | 1.83(0.512–6.54)  | 0.353         | 1.44(0.390–5.634)   | 0.598          |

PCV: Polypoidal choroidal vasculopathy, H/o: History, OR: Odds ratio.

https://doi.org/10.1371/journal.pone.0231901.t002

Fig 3. The proportions of patients with PCV, CNVM and RAP in each clinical category.

https://doi.org/10.1371/journal.pone.0231901.g003
Table 3. Fundus fluorescein and Indocyanine green angiogram features in patients with PCV.

| Feature                        | Exudative (N = 25) | Hemorrhagic (N = 38) | Mixed (N = 10) | p     | Overall (N = 73) |
|--------------------------------|--------------------|----------------------|----------------|-------|-----------------|
|                                | n (%)              | n (%)                | n (%)          |       | n (%)           |
| BVN*                           |                    |                      |                |       |                 |
| Present                        | 13 (52%)           | 22 (58%)             | 7 (70%)        | 0.62  | 42 (58%)        |
| Absent                         | 12 (48%)           | 16 (42%)             | 3 (30%)        |       | 31 (42%)        |
| Polyp                          |                    |                      |                |       |                 |
| None                           | 2 (8%)             | 3 (7.9%)             | 1 (10%)        | 0.09  | 6 (8.2%)        |
| Single                         | 9 (36%)            | 13 (34.2%)           | 3 (30%)        |       | 25 (34.3%)      |
| Multiple                       | 9 (36%)            | 17 (44.7%)           | 3 (30%)        |       | 29 (39.7%)      |
| Cluster                        | 5 (20%)            | 5 (13.2%)            | 3 (30%)        |       | 13 (17.8%)      |
| Speckled hyperfluorescence     |                    |                      |                |       |                 |
| Present                        | 11 (44%)           | 21 (55.3%)           | 8 (80%)        | 0.15  | 40 (54.8%)      |
| Absent                         | 14 (56%)           | 17 (44.7%)           | 2 (20%)        |       | 33 (45.2%)      |
| Hyperfluorescence foci         |                    |                      |                |       |                 |
| Present                        | 5 (20%)            | 7 (18.4%)            | 1 (10%)        | 0.78  | 13 (17.8%)      |
| Absent                         | 20 (80%)           | 31 (81.6%)           | 9 (90%)        |       | 60 (82.2%)      |

*BVN: Branching vascular network.

https://doi.org/10.1371/journal.pone.0231901.t003

Table 4. OCT features in the patients with PCV.

| Feature            | Exudative (N = 25) | Hemorrhagic (N = 38) | Mixed (N = 10) | p     | Overall (N = 73) |
|--------------------|--------------------|----------------------|----------------|-------|-----------------|
|                    | n (%)              | n (%)                | n (%)          |       | n (%)           |
| PED*               |                    |                      |                |       |                 |
| None               | 0 (0%)             | 1 (2.6%)             | 0 (0%)         |       | 1 (1.4%)        |
| Fibrovascular PED*| 8 (32%)            | 5 (13.2%)            | 3 (30%)        | 0.093 | 16 (21.9%)      |
| Hemorrhagic PED*  | 2 (8%)             | 14 (36.8%)           | 1 (10%)        |       | 17 (23.3%)      |
| Serosanguinous PED*| 15 (60%)           | 18 (47.4%)           | 6 (60%)        |       | 39 (53.4%)      |
| SRF†              |                    |                      |                |       |                 |
| Present            | 20 (80%)           | 35 (92.1%)           | 9 (90%)        | 0.007 | 47 (6.4%)       |
| Absent             | 5 (20%)            | 3 (7.9%)             | 1 (10%)        | 0.35  | 9 (12.3%)       |
| SRH‡              |                    |                      |                |       |                 |
| Present            | 10 (40%)           | 29 (76.3%)           | 8 (80%)        | 0.007 | 47 (6.4%)       |
| Absent             | 15 (60%)           | 9 (23.7%)            | 2 (20%)        |       | 26 (36.6%)      |
| Peaked PED*        |                    |                      |                |       |                 |
| Present            | 16(64%)            | 27(71.05%)           | 6(660%)        | 0.735 | 49 (67.1%)      |
| Absent             | 9(36%)             | 11(28.95%)           | 4(40%)         |       | 24 (32.8%)      |
| Tomographic notch  |                    |                      |                |       |                 |
| Present            | 18(72.5)           | 26(68.4%)            | 6(660%)        | 0.785 | 50 (68.5%)      |
| Absent             | 7(28%)             | 12(31.6%)            | 4(40%)         |       | 23 (31.5%)      |
| Double Layer sign  |                    |                      |                |       |                 |
| Present            | 13(52%)            | 24(63.1%)            | 8(80%)         | 0.294 | 45 (61.6%)      |
| Absent             | 12(48%)            | 14(36.8%)            | 2(20%)         |       | 28 (38.4%)      |

*PED: Pigment epithelial detachment,
†SRF: Subretinal fluid,
‡SRH: Subretinal hemorrhage.

https://doi.org/10.1371/journal.pone.0231901.t004
history of hypertension and 12.66% and 11% had a history of diabetes respectively. In our series 37 (50.68%) patients with PCV were hypertensive and 41.09% had history of diabetes.

### Table 5. Comparing the prevalence of PCV across various studies.

| Author              | Year | Country | Mean age (years) | Diagnosis tools used                      | Study Population   | N  | Unilateral% | Prevalence |
|---------------------|------|---------|------------------|-------------------------------------------|--------------------|----|-------------|------------|
| Yannuzzi et al [5]  | 1999 | USA     | 74.4             | ICGA+ features                            | Hospital based     | 167| 46.2        | 7.80%      |
| Lafaut et al [2]    | 2000 | Belgium | NA               | FP†, FFA**, and ICGA†                     | Hospital based     | 374| 39          | 4.00%      |
| Scassellati–sforzolini et al [10] | 2001 | Italy   | 70.2             | FFA** and ICGA*                           | Hospital based     | 194| 78.9        | 9.80%      |
| Kwok et al [18]     | 2002 | China   | 65.1             | ICGA+ features                            | Hospital based     | 19 | 84.2        | 9.30%      |
| Sho et al [12]      | 2003 | Japan   | 68.4             | FP* and ICGA*                             | Hospital based     | 418| 90          | 23.92%     |
| Ladis et al [19]    | 2004 | Greece  | 72.5             | ICGA+ features                            | Hospital based     | 268| 45.5        | 8.20%      |
| Wen et al [13]      | 2004 | China   | 68.3             | FP* FFA** and ICGA*                       | Hospital based     | 166| 86.5        | 22.30%     |
| Maruko et al [3]    | 2007 | Japan   | NA               | ICGA+ features                            | Hospital based     | 289| 82.9        | 54.70%     |
| Liu et al [14]      | 2007 | China   | 65.4             | FP* FFA** and ICGA*                       | Hospital based     | 155| 76.3        | 24.50%     |
| Beyon et al [15]    | 2008 | Korea   | 64.6             | FP* FFA** and ICGA*                       | Hospital based     | 79 | 75.9        | 24.60%     |
| Song et al [20]     | 2009 | Korea   | 57.2             | FP* FFA** and ICGA*                       | Population based   | 10890| 90        | 22.20%     |
| Li et al [21]       | 2014 | China   | NA               | OCT‡                                       | Population based   | 3468| 94.1        | 0.30%      |
| Cackett et al [16]  | 2010 | China   | 68.3             | ICGA+ features                            | Hospital based     | 123| 87.8        | 55.6%      |
| Bhoomibunchoo et al [4] | 2017 | Thailand | 59.5             | FP* and ICGA*                             | Hospital based     | 140| 93          | 77.50%     |
| Yadav et al [11]    | 2017 | UK      | 75.4             | ICGA+ features                            | Hospital based     | 492| NA          | 9.14%      |
| Our study           | 2018 | India   | 65.3             | FP*, FFA**, OCT‡ and ICGA*                | Hospital based     | 147| 82.2        | 9.29%      |

ICGA: Indocyanine green angiogram,
FP; fundus photo,
OCT: Optical coherence tomography,
FFA: Fundus fluorescein angiogram.

https://doi.org/10.1371/journal.pone.0231901.t005

Fig 4. Multiple modalities role in PCV diagnosis.

https://doi.org/10.1371/journal.pone.0231901.g004
Given that hypertension is highly prevalent in this age group in the Asian population, an association of hypertension and PCV cannot be elucidated from small clinic-based studies.

Our study confirmed that macular polyps are more common in Asian population. PCVs were initially thought to occur in the peripapillary location. Subsequently, PCV lesions have been described in macular and mid periphery with ethnic variations. In our study, majority of polyps were macular (64.4%), followed by extra macular group 15.1%. Peripapillary polyps were found in only 8.2% of the eyes. Umaya et al [24] observed 94% polyps were macular and 9% were peripapillary in their study on 14 eyes. Anantharaman et al [9] also reported 45% being subfoveal 18% juxta foveal polyps and 18% peripapillary polyps in their study on 45 eyes in Indian patients. In contrast, studies from Europeans showed an equal distribution of macular and peripapillary location [25].

Our study showed that the prevalence increased with increasing age; majority being unilateral and macular. Hemorrhagic PCVs were slightly more common than the exudative subtypes. Sho et al [12] in his series reported 59% had exudative pattern and 30% had hemorrhagic pattern. Byeon et al [15] also reported higher rates of exudative pattern in 52% and hemorrhagic pattern in 34.7% of cases. Similar to our study, Bhoombunchoo et al [4] reported hemorrhagic pattern to be 88.79% and exudative pattern in 11.21%. Uyama et al [24] and Ahuja et al [23] also reported higher percentage of hemorrhagic pattern which correlates with our study. We observed that the ICGA and OCT features of PCV do not statistically vary between the three main clinical presentations of PCV.

Fig 4 shows that despite multiple modalities like FFA and OCT, ICG was the most helpful in diagnosis of PCV. The polyps were seen in 91.8% cases. However, features picked up on multimodal imaging collaborates in the diagnosis of PCV.

The merit of the present study is that it is the first study to examine the prevalence, risk factors and imaging characteristics of PCV in an Indian population from a tertiary center. However, our study also has several limitations. First, we may have introduced study sample selection bias because the study population was obtained from the EMR and only patients with multimodal imaging were selected. Our study results indicate that PCV may be present irrespective of the clinical presentation, suggesting that our study may have under-reported the prevalence of PCV. However, a prospective, multimodal imaging in a population-based prevalence study of PCV in an Indian population is not a feasible option.

Second, the possibility of potential bias in ascertaining history-related variables from EMR records should also be kept in mind; this was true particularly with regard to diabetes, hypertension and hypercholesteremia.

In conclusion, in the present study, we found that PCV is present in approximately half our study cohort and the prevalence, OCT and ICGA characteristics of PCV are similar irrespective of the clinical presentation. Therefore, multimodal imaging is recommended for all patients presenting with signs and symptoms of neovascular AMD.

**Acknowledgments**

SNVR group comprises of Dr Pramod Bhende, Dr Dhanashree Ratra, Dr Ekta Rishi, Dr Pukhraj Rishi, Dr Chetan Rao, Dr Pradeep S, Dr Suganeswari G, Dr Vinata Muralidharan, Dr Rupak Roy, Dr Sudipta Das, Dr Kumar Saurabh., Dr Jaydeep Avinash Walinjkar, Dr Jaya Prakash V, Dr Charanya C, Dr Sruthi S.

**Author Contributions**

**Conceptualization:** Parveen Sen, Rajiv Raman.

**Data curation:** Meenakshi Kumar, Sangeetha E. Moptom.
Formal analysis: Meenakshi Kumar, Sangeetha E. Moiptom, Parveen Sen, Rajiv Raman.

Investigation: Parveen Sen, Vikas Khetan.

Methodology: Meenakshi Kumar, Sangeetha E. Moiptom, Parveen Sen, Vikas Khetan, Muna Bhende, Rajiv Raman.

Project administration: Rajiv Raman.

Supervision: Parveen Sen, Vikas Khetan, Muna Bhende, Sobha Sivaprasad, Rajiv Raman.

Validation: Parveen Sen, Vikas Khetan, Muna Bhende, Sobha Sivaprasad, Rajiv Raman.

Writing – original draft: Meenakshi Kumar, Sangeetha E. Moiptom, Rajiv Raman.

Writing – review & editing: Meenakshi Kumar, Parveen Sen, Vikas Khetan, Muna Bhende, Sobha Sivaprasad, Rajiv Raman.

References
1. Wong C, Wong T, Cheung C. Polypoidal choroidal vasculopathy in Asians. Journal of clinical medicine. 2015 May; 4(5):782–821. https://doi.org/10.3390/jcm4050782 PMID: 26239448
2. Lafaut BA, Leys AM, Snyers B, Rasquin F, De Laey JJ. Polypoidal choroidal vasculopathy in Caucasians. Graefe’s archive for clinical and experimental ophthalmology. 2000 Sep 1; 238(9):752–9. https://doi.org/10.1007/s004170000180 PMID: 11045343
3. Maruko I, Iida T, Saito M, Nagayama D, Saito K. Clinical characteristics of exudative age-related macular degeneration in Japanese patients. American journal of ophthalmology. 2007 Jul 1; 144(1):15–22. https://doi.org/10.1016/j.ajo.2007.03.047 PMID: 17509509
4. Bhoomibunchoo C, Yospaiboon Y, Thongsupan S, Rojanaporn D, Watanachai N, Jiraratantasopa P, et al. Idiopathic polypoidal choroidal vasculopathy in Thai patients with clinical and angiographic choroidal neovascularization. Clinical ophthalmology (Auckland, NZ). 2017; 11:317.
5. Yannuzzi LA, Wong DW, Sforzolini BS, Goldbaum M, Tang KC, Spaide RF, et al. Polypoidal choroidal vasculopathy and neovascularized age-related macular degeneration. Archives of Ophthalmology. 1999 Nov 1; 117(11):1503–10. https://doi.org/10.1001/archoph.117.11.1503 PMID: 10565519
6. Raman R, Pal SS, Ganesan S, Gella L, Vaiatheeswaran K, Sharma T. The prevalence and risk factors for age-related macular degeneration in rural–urban India, Sankara Nethralaya Rural–Urban Age-related Macular degeneration study, Report No. 1. Eye. 2016 May; 30(5):688. https://doi.org/10.1038/eye.2016.14 PMID: 26915746
7. Tan CS, Ngo WK, Chen JP, Tan NW, Lim TH, EVEREST Study Group. EVEREST study report 2: imaging and grading protocol, and baseline characteristics of a randomised controlled trial of polypoidal choroidal vasculopathy. British Journal of Ophthalmology. 2015 May 1; 99(5):624–8. https://doi.org/10.1136/bjophthalmol-2014-305674 PMID: 25758601
8. Yannuzzi LA, Negrão S, Tomohiro II, Carvalho C, Rodriguez-Coleman H, Slakter J, et al. Retinal angiomatous proliferation in age–related macular degeneration. Retina. 2012 Feb 1; 32:416–34. https://doi.org/10.1097/iae.0b013e31823f9b3b PMID: 22451953
9. Anantharaman G, Sheth J, Bhende M, Narayanam R, Natarajan S, Rajendran A, et al. Polypoidal choroidal vasculopathy: Pearls in diagnosis and management. Indian journal of ophthalmology. 2018 Jul; 66(7):896. https://doi.org/10.4103/ijo.IJO_1136_17 PMID: 29941728
10. Scassellati-Sforzolini B, Mariotti C, Bryan R, Yannuzzi LA, Giuliani M, Giovannini A. Polypoidal choroidal vasculopathy in Italy. Retina. 2001 Apr 1; 21(2):121–5. https://doi.org/10.1097/00006982-200104000-00004 PMID: 11321137
11. Yadav S, Parry DG, Beare NA, Pearce IA. Polypoidal choroidal vasculopathy: a common type of neovascular age-related macular degeneration in Caucasians. British Journal of Ophthalmology. 2017 Oct 1; 101(10):1377–80. https://doi.org/10.1136/bjophthalmol-2016-310074 PMID: 28270486
12. Sho K, Takahashi K, Yamada H, Wada M, Nagai Y, Otsuji T, et al. Polypoidal choroidal vasculopathy: incidence, demographic features, and clinical characteristics. Archives of Ophthalmology. 2003 Oct 1; 121(10):1392–6. https://doi.org/10.1001/archoph.121.10.1392 PMID: 14557174
13. Wen F, Chen C, Wu D, Li H. Polypoidal choroidal vasculopathy in elderly Chinese patients. Graefe’s Archive for Clinical and Experimental Ophthalmology. 2004 Aug 1; 242(8):625–9. https://doi.org/10.1007/s00417-003-0667-z PMID: 15257461
14. Liu Y, Wen F, Huang S, Luo G, Yan H, Sun Z, et al. Subtype lesions of neovascular age-related macular degeneration in Chinese patients. Graefe's Archive for Clinical and Experimental Ophthalmology. 2007 Oct 1; 245(10):1441–5. https://doi.org/10.1007/s00417-007-0575-8 PMID: 17406882

15. Byeon SH, Lee SC, Oh HS, Kim SS, Koh HJ, Kwon OW. Incidence and clinical patterns of polypoidal choroidal vasculopathy in Korean patients. Japanese journal of ophthalmology. 2008 Feb 1; 52(1):57–62. https://doi.org/10.1007/s10384-007-0498-2 PMID: 18369702

16. Cackett P, Wong D, Yeo I. A classification system for polypoidal choroidal vasculopathy. Retina. 2009 Feb 1; 29(2):187–91. https://doi.org/10.1097/IAE.0b013e318188c839 PMID: 18827731

17. Honda S, Matsumiya W, Negi A. Polypoidal choroidal vasculopathy: clinical features and genetic predisposition. Ophthalmologica. 2014; 231(2):59–74. https://doi.org/10.1159/000355488 PMID: 24280967

18. Kwok AK, Lai TY, Chan CW, Neoh EL, Lam DS. Polypoidal choroidal vasculopathy in Chinese patients. British Journal of Ophthalmology. 2002 Aug 1; 86(8):892–7. https://doi.org/10.1136/bjo.86.8.892 PMID: 12140211

19. Ladas ID, Rouvas AA, Moschos MM, Synodinos EE, Karagiannis DA, Koutsandrea CN. Polypoidal choroidal vasculopathy and exudative age-related macular degeneration in Greek population. Eye. 2004 May; 18(5):455. https://doi.org/10.1038/sj.eye.6700706 PMID: 15131673

20. Song SJ, Youm DJ, Chang Y, Yu HG. Age-related macular degeneration in a screened South Korean population: prevalence, risk factors, and subtypes. Ophthalmic epidemiology, 2009 Jan 1; 16(5):304–10. PMID: 19874110

21. Li Y, You QS, Wei WB, Xu J, Chen CX, Wang YX, et al. Polypoidal choroidal vasculopathy in adult chinese: the Beijing Eye Study. Ophthalmology. 2014 Nov; 121(11):2290. https://doi.org/10.1016/j.ophtha.2014.06.016 PMID: 25109927

22. Yannuzzi LA. Idiopathic polypoidal choroidal vasculopathy. Presented at the Macula Society Meeting, Miami, 5 February 1982.

23. Ahuja RM, Stanga PE, Vingerling JR, Reck AC, Bird AC. Polypoidal choroidal vasculopathy in exudative and haemorrhagic pigment epithelial detachments. British journal of ophthalmology. 2000 May 1; 84 (5):479–84. https://doi.org/10.1136/bjo.84.5.479 PMID: 10781511

24. Uyama M, Wada M, Nagai Y, Matsubara T, Matsunaga H, Fukushima I, et al. Polypoidal choroidal vasculopathy: natural history. American journal of ophthalmology. 2002 May 1; 133(5):639–48. https://doi.org/10.1016/s0002-9394(02)01404-6 PMID: 11992861

25. Imamura Y, Engelbert M, Iida T, Freund KB, Yannuzzi LA. Polypoidal choroidal vasculopathy: a review. Survey of ophthalmology. 2010 Nov 1; 55(6):501–15. https://doi.org/10.1016/j.survophthal.2010.03.004 PMID: 20850857