# COMPARISON OF FUNDUS FLUORESCEIN ANGIOGRAPHY AND OPTICAL COHERENCE TOMOGRAPHY IN AGE-RELATED MACULAR DEGENERATION

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**ABSTRACT**

**BACKGROUND**

Age-Related Macular Degeneration (ARMD) is a common, progressive degenerative disorder of the macula and affects people above 50. Degenerative lesions of macula have been classified clinically into two forms the dry and the wet/neovascular, both the forms can lead on to loss of vision. Fundus photography and fluorescein angiography is highly valuable in the diagnosis, management and for monitoring the treatment of retinal and macular diseases. Optical coherence tomography is now becoming a popular tool in the early diagnosis of age-related macular degeneration.

**MATERIALS AND METHODS**

50 patients (100 eyes) attending the Outpatient Department of Ophthalmology at Government Vellore Medical College who are diagnosed clinically to have age-related macular degeneration were enrolled for this study after getting their consent. Complete history taking, ocular examination, fundus fluorescein angiography and optical coherence tomography were done and observations recorded. This is a prospective hospital-based study. The period of our study was from June 2015-June 2016. Ethical committee approval was obtained for conducting the study.

Inclusion Criteria- All age group, both sexes, newly-diagnosed patients to have ARMD clinically.

Exclusion Criteria- Patients already on treatment for ARMD, patients with media opacities obscuring fundus examination, patients who has undergone previous laser treatment patients having coexisting other retinal and macular diseases.

**RESULTS**

Maximum number of patients are in the age group of 50-70 yrs. female preponderance. Dry ARMD is common among females (34%) and wet ARMD common in males (26%), smoking being the risk factor. 88% had bilateral disease. 62% of the eyes by FFA and 61% of the eyes by OCT had dry ARMD and 32% of the eyes by FFA and 33% by OCT had wet ARMD. In our study, both FFA and OCT showed subfoveal CNVM as the most common type of classic CNVM.

**CONCLUSION**

Fundus Fluorescein Angiography is the gold standard procedure for screening ARMD and detection of dry ARMD, but OCT is more specific diagnostic tool in detecting early subretinal neovascular membrane and also to assess the extent, location and activity of the neovascular membranes. Hence, OCT is better diagnostic tool than FFA in diagnosing early wet ARMD and thus helps in early management of patients with ARMD and thereby preventing severe visual loss due to ARMD.

**KEYWORDS**

ARMD, FFA, OCT, CNVM.

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## BACKGROUND

Age-Related Macular Degeneration (ARMD) is a common, degenerative disorder of the macula, which is chronic and progressive in nature and affects individuals older than 50 years.(1) The disease clinically manifest as drusen, geographical RPE atrophy, serous retinal pigment epithelium detachment and choroidal neovascularisation.(2) Age-Related Macular Degeneration (ARMD) is now the leading cause of irreversible blindness. Research into ARMD is assuming increasing importance because of high prevalence of this disease in western society and eastern Asia. Since, the population above 80 yrs. is about to increase by 105% by 2020, the prevalence of this disease is also expected to rise dramatically.(3)

Degenerative lesions of macula have been classified clinically into two forms the dry/atrophic/non-neovascular and the wet/exudative/neovascular, both the forms can lead

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on to loss of vision. About 15% of ARMD patients presents with neovascular form of disease.[4]

Fundus photography and fluorescein angiography is highly valuable for understanding the anatomy, pathophysiology and pathology of choroid and retina and have helped in the diagnosis, management and for monitoring the treatment of retinal and macular diseases. An understanding and an ability to interpret a fluorescein angiogram is essential to accurately diagnose, evaluate and treat the patients with retinal and macular disease. Optical coherence tomography is now becoming a popular tool in the early diagnosis of age-related macular degeneration.[5]

## AIM AND OBJECTIVE

The aim of our study is to compare fundus fluorescein angiography and optical coherence tomography in diagnosing Age-Related Macular Degeneration.

## MATERIALS AND METHODS

50 patients (100 eyes) attending the outpatient department of ophthalmology at Government Vellore Medical College who are diagnosed clinically to have age-related macular degeneration were enrolled for this study after getting their consent. This is a prospective hospital-based study. The period of our study was from June 2015-June 2016. Ethical committee approval was obtained for conducting the study.

After obtaining informed consent from the patient, following evaluations were done. Relevant ocular history, personal history such as smoking/alcoholic consumption, h/o diabetes/hypertension. Complete ocular examination such as assessment of best corrected visual acuity, slit lamp evaluation of anterior segment both direct and indirect ophthalmoscopy and slit lamp biomicroscopy using 90 D to evaluate the posterior segment, fundus photography taken and FFA done as per procedure, optical coherence tomography done and observation recorded and evaluated.

### Inclusion Criteria

All age group both sexes, newly-diagnosed patients to have ARMD clinically.

### Exclusion Criteria

- Patients already on treatment for ARMD.
- Patients with media opacities obscuring fundus examination patients who has undergone previous laser treatment.
- Patients having coexisting other retinal and macular diseases.

## RESULTS

In this study, a total of 50 patients clinically diagnosed to have ARMD were enrolled and after obtaining informed consent, they were subjected to thorough ocular examination.

Maximum no. of patients in our study were in the age group of 50-70 years. The range included from 40-80 yrs. This shows that advancing age is a risk factor for ARMD.[6]

No. of males in the study were 21 accounting for 42% and females were 29 in no. accounting for 58%. This shows that the disease has female preponderance. Females outnumbered the males in all age groups except in 61-70 years group were females and males were same in number.[7]

In our study, non-exudative type of ARMD accounted for 64% (32). Out of which 65.6% were females and 34.3% were males. Exudative type accounted for 36% out of which 44.5% were females and 55.5% were males. Increased incidence of wet ARMD in males maybe due to smoking, which might have increased the risk for CNVM.[8]

The most common symptom was defective vision accounting for 92%. 4% of the individuals with disciform scar had scotoma and 12% of the patients with CNVM had metamorphopsia by Amsler's grid evaluation.[4]

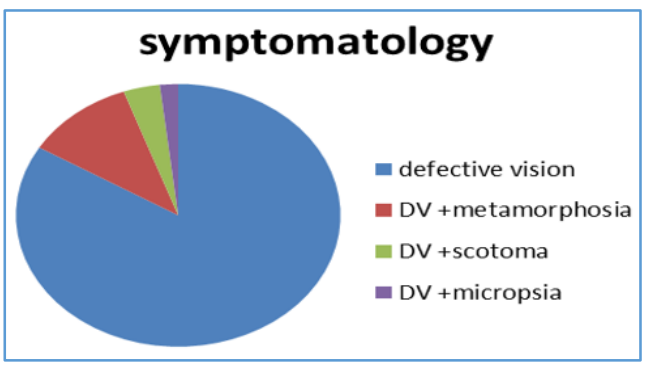



***Figure 1***

In our study, 36 patients were hypertensive and 40 patients had hyperlipidaemia, which maybe a risk factor for the development of ARMD. 16 men out of 21 are smokers, which may also contribute to the increased incidence of exudative ARMD in males.[4]

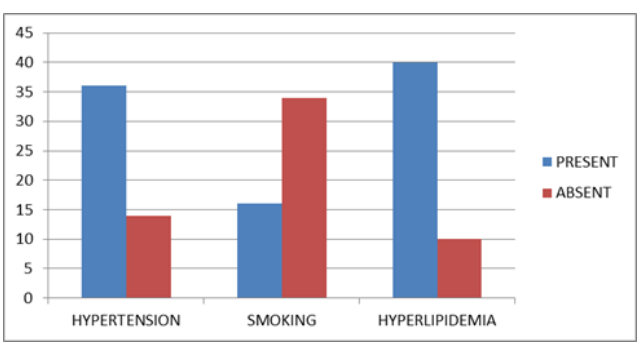



***Figure 2***

32 eyes with drusen had a visual acuity better than 6/18 and 16 eyes with drusen, 9 eyes with RPE alteration, 3 eyes with geographical atrophy and 18 eyes wet ARMD had visual acuity of 6/60-6/24. 2 eyes with geographical atrophy and 14 eyes wet ARMD had acuity of 6/60-1/60 and 4 cases with disciform scar had a visual acuity of CFCF.[9]

In our study, only 12% of patients had unilateral disease and 88% had bilateral disease. This shows that the disease has bilateral presentation.

In our study consisting of 100 eyes, 6% of the eyes had normal fundus by both fundus fluorescein angiography and optical coherence topography. By FFA, 62% of the eyes was diagnosed to have dry ARMD and 32% of the eyes diagnosed to have wet ARMD. 61% of eyes was diagnosed to have dry ARMD and 33% of the eyes was diagnosed to have wet ARMD by OCT.[10]

| Types | FFA (No. of Eyes) | OCT (No. of Eyes) |
|---|---|---|
| Normal | 6 (6%) | 6 (6%) |
| Dry | 62 (62%) | 61 (61%) |
| Wet | 32 (32%) | 33 (33%) |
| **Total** | **100** | **100** |

***Table 1***

Of the 62 eyes diagnosed to have dry ARMD by FFA, 77.4% was diagnosed to have drusen in that, 72.5% (45 eyes) of the patients showed hyperfluorescence in FFA and 4.83% (3 eyes) had hypofluorescence because they are hydrophobic drusens with high lipid content, which blocks the underlying choroidal fluorescence. 14.5% eyes had RPE alterations and 8.06% had geographical atrophy has the feature manifesting has retinal hyperfluorescence due to window defect.

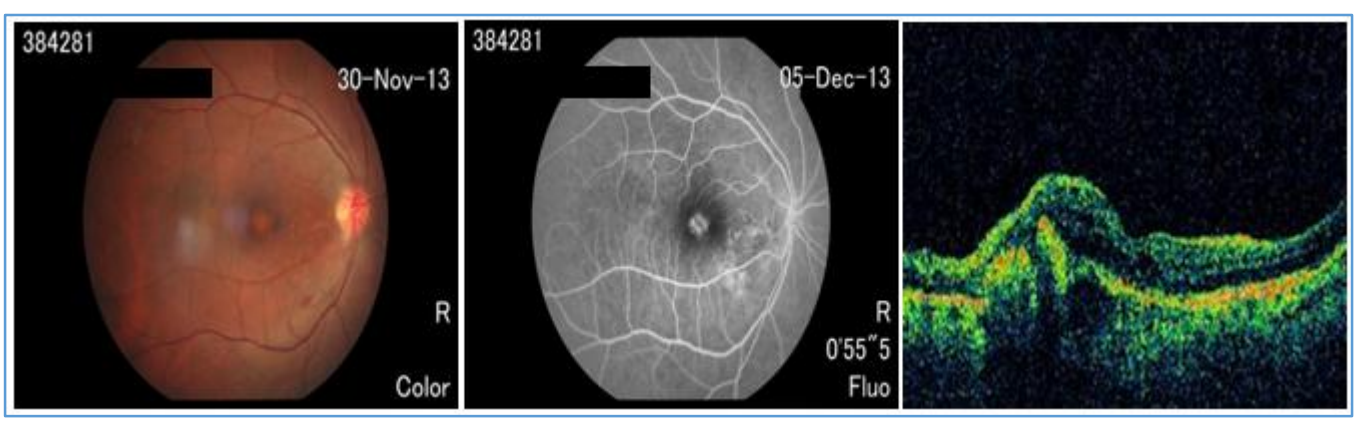
Of the 61 eyes diagnosed to have dry ARMD by OCT, 77.04% of eyes had drusen manifesting has RPE elevation with moderate reflectivity, 14.75% had RPE alteration and 8.19% had geographical atrophy manifesting as retinal thinning in OCT and hyporeflectivity, 1 eye with hydrophobic drusen showed blocked fluorescence in FFA, but by OCT, it was diagnosed as early subfoveal CNVM manifesting as retinal thickening and hyperreflectivity with well-defined edges.[11]

***Hydrophobic Drusen*** ***Blocked Fluorescence in FFA*** ***Excrescence with sub RPE fluid and SF CNVM***

In our study, 32% of eyes was diagnosed to have wet ARMD by FFA and 33% of the eyes was diagnosed to have wet ARMD by OCT.

| Types | FFA | OCT |
|---|---|---|
| Classic CNVM | 21 (65.6%) | 24 (72.72%) |
| Occult CNVM | 2 (6.2%) | 2 (6.06%) |
| Serous PED | 4 (12.5%) | 3 (9.37%) |
| Haemorrhagic PED | 1 (3.1%) | 1 (3.1%) |
| Disciform scar | 4 (12.5%) | 3 (9.09%) |
| **Total** | **32** | **33** |

***Table 2***



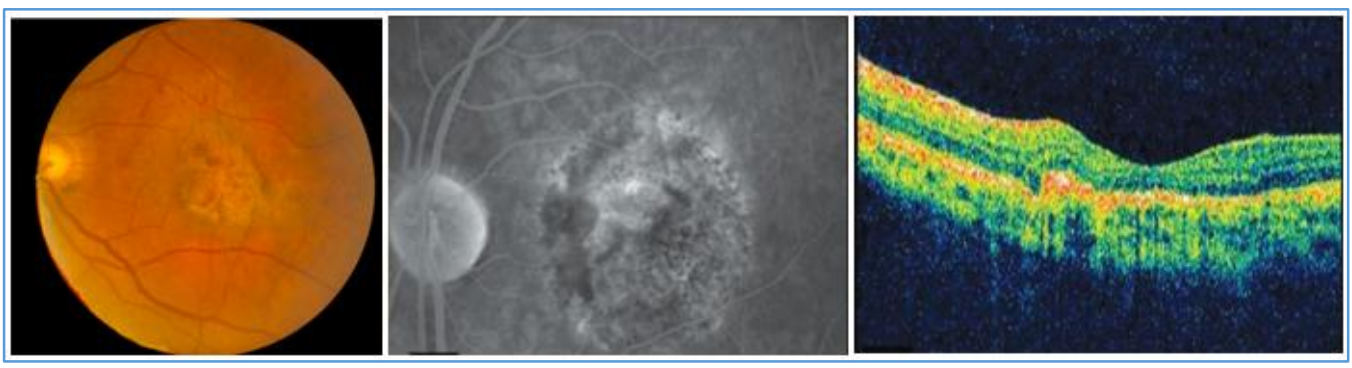

***Serous PED*** ***Pooling of Dye in FFA*** ***Serous PED with SF CNVM***

In our study, 65.6% (21 eyes) had classic CNVM by FFA and 72.72% had classic CNVM by OCT. 6.2% patients by FFA and 6.06% patients by OCT was diagnosed to have occult CNVM.

12.5% of the patients were diagnosed to have serous PED by FFA and only 9.37% of the patients had serous PED in OCT. This is because 1 eye with serous PED, which showed pooling in FFA had a subfoveal classical CNVM in OCT seen as a notch between elevation and small mound.[12] Thus, OCT detected CNVM at an early stage. 3.1% of the individuals had haemorrhagic PED in both FFA and OCT. FFA showed blocked fluorescence with overlying vessels are seen. OCT showed retinal thickening with hyporeflectivity.

12.5% of the patients had disciform scar by FFA manifesting has blocked fluorescence and only 9.09% was diagnosed to have disciform scar by OCT seen as retinal thinning. One eye which showed blocked fluorescence in FFA had retinal thickening with increased reflectivity in OCT diagnosed has subfoveal CNVM.[13]

In our study, 52.3% had subfoveal CNVM by FFA and 58.33% had subfoveal CNVM by OCT. Hence, this forms the most common type of CNVM in our study. 28.57% in FFA and 25% in OCT had juxtafoveal CNVM. 19% in FFA and 16.6% in OCT had extra foveal CNVM.



***Disciform Scar*** ***FFA showing Late Staining*** ***OCT showing Retinal Thinning with SF CNVM***

**DISCUSSION**

Comparison between Fundus Fluorescein Angiography and Optical Coherence Tomography in ARMD has been studied by few other researchers worldwide.

In our study, there is significant difference in representation of males as well as females, males accounting for 42% and females 58%. Incidence rates within Beaver dam population also suggest a gender difference. Women over 60 years had twice the incidence of early ARMD compared with men. AREDS study also found women had higher risk for drusen formation.

In our study, the prevalence, incidence and progression of all forms of ARMD rise steeply with increasing age. There is 17 fold increased risk of ARMD comparing the oldest to youngest age group in Framingham study. In the Waterman study, the prevalence of moderate to advanced ARMD doubled with each decade after 60 years.

In our study, nonexudative type of ARMD accounted for 64% (32) out of which 65.6% were females and 34.3% were males. Exudative type accounted for 36% out of which 44.5% were females and 55.5% were males. Increased incidence of wet ARMD in males maybe due to smoking, which might have increased the risk for CNVM.[14]

Our study was compared with Querishi et al study in the occurrence of disease between 2 eyes. The results were similar to our study. In our study, 88% of the individuals had bilateral representation and in Querishi et al study 74% had bilateral presentation. This proves that the disease is almost bilateral. Symptoms of our study was compared with Querishi et al study and the most common symptom being defective vision followed by metamorphopsia and scotoma.[15]

**Classification of ARMD by FFA and OCT**

| | | Our Study | Querishi et al Study | Sandhu et al Study | Mokwa et al Study |
|---|---|---|---|---|---|
| FFA | DRY | 62% | 82.32% | 61.7% | 66.3% |
| | WET | 32 % | 17.68% | 38.3% | 33.7% |
| OCT | DRY | 61 % | 80.58% | 59.2% | 62.48% |
| | WET | 33 % | 19.42% | 40.8% | 37.52% |

***Table 3***

The results of our study was similar to the results of Sandhu et al and Mokwa et al study. In our study, the incidence of dry and wet ARMD diagnosed by FFA is 62% and 32% and by OCT it is 61% and 33%.

In Querishi et al study, 82.3% accounted for dry and 17.68% for wet by FFA and 80.58% of dry and 19.42% of wet ARMD by OCT. These studies show that dry ARMD is the most common type of ARMD.

**DRY ARMD**

| | | Our Study | Querishi et al Study | Sandhu et al Study | Mokwa et al Study |
|---|---|---|---|---|---|
| FFA | Drusen | 77.4% | 88.62% | 69.46% | 71.46% |
| | RPE alteration | 14.05% | 4.60% | - | - |
| | Geographical atrophy | 8.05% | 6.78% | 30.54% | 28.54% |
| OCT | Drusen | 77.04% | 84.19% | 67.89% | 70.31% |
| | RPE alteration | 14.76% | 11.61% | - | - |
| | Geographical atrophy | 8.2% | 4.20% | 32.11% | 29.69% |

***Table 4***

**WET ARMD**

| | | Our Study | Querishi et al Study | Sandhu et al Study | Mokwa et al Study |
|---|---|---|---|---|---|
| FFA | Classic CNVM | 65.6% | 68.62 | 63.48 | 77.32 |
| | Occult CNVM | 6.2% | 16.90 | 12.64 | 22.68 |
| | Ped | 15.6% | - | 8.20 | - |
| | Disciform scar | 12.5% | 34.48 | 15.68 | - |
| OCT | Classic CNVM | 72.72% | 58.62 | 74.74 | 84.23 |
| | Occult CNVM | 6.06% | 27.59 | 14.28 | 15.77 |
| | Ped | 12.47% | - | 4.20 | - |
| | Disciform scar | 9.09% | 13.79 | 6.78 | - |

***Table 5***

In our study, 65.6% had classic CNVM by FFA and 72.72% by OCT. The results were almost similar in Querishi et al, Sandhu et al and Mokwa et al study.

12.5% of the patients were diagnosed to have serous PED by FFA and only 9.37% of the patients had serous PED in OCT. This is because one eye with serous PED, which showed pooling in FFA had a subfoveal classical CNVM in OCT seen as a notch between elevation and small mound. Thus, OCT detected CNVM at an early stage.[16]

12.5% of the patients had disciform scar by FFA manifesting has blocked fluorescence and only 9.09% was diagnosed to have disciform scar by OCT seen as retinal thinning. One eye which showed blocked fluorescence in FFA had retinal thickening with increased reflectivity in OCT diagnosed has subfoveal CNVM.

**STATISTICAL ANALYSIS**

| | FFA | OCT | P value |
|---|---|---|---|
| Normal | 6% | 6% | 1 |
| Dry | 62% | 61% | 0.046 |
| Wet | 32% | 33% | 0.046 |

***Table 6***

Chi-square test $\chi 2 = 6.171$ with 2 degrees of freedom. ($P = 0.046$), i.e. $P<0.05$.

The proportions of observations in different columns of the contingency table vary from row to row. The two characteristics that define the contingency table are significantly related ($P = 0.046$).

Comparison of FFA and OCT in normal eye had a P value of 1, which is insignificant. Comparison of FFA and OCT in dry ARMD had a P value of 0.046, which is significant.

Comparison of FFA and OCT in wet ARMD had a P value of 0.046, which is also significant.

| DRY ARMD | | Our Study | Sandhu et al Study | Mokwa et al Study |
|---|---|---|---|---|
| FFA | Sensitivity | 97.81% | 96.4% | 92% |
| | Specificity | 95.82% | 66.2% | 82% |
| OCT | Sensitivity | 96.31% | 94.2% | 89% |
| | Specificity | 98.39% | 89.4% | 76% |

***Table 7***

The results of the above table shows that fundus fluorescein angiography is more sensitive in diagnosing dry ARMD than wet ARMD.

| WET ARMD | | Our Study | Sandhu et al Study | Mokwa et al Study |
|---|---|---|---|---|
| FFA | Sensitivity | 97.81% | 78.6% | 88% |
| | Specificity | 95.82% | 82.7% | 76% |
| OCT | Sensitivity | 96.31% | 82.2% | 94% |
| | Specificity | 98.39% | 89.3% | 84% |

***Table 8***

The results of the above table shows that OCT is more sensitive in diagnosing early wet ARMD than FFA. Sandhu et al study and Mokwa et al study also showed increased sensitivity for OCT in diagnosing wet ARMD.[17]

## CONCLUSION

Age-related macular degeneration is a progressive, chronic degenerative disorder of macula affecting the elder age group and it has become the leading cause of irreversible blindness worldwide. Hence, various researches are going on in ARMD in how to prevent the occurrence, early detection by appropriate means and prompt treatment with followup to reduce the prevalence of blindness due to age-related macular degeneration. The various clinical manifestations of this disease entity includes dry ARMD (drusen, geographical atrophy) and wet ARMD (pigment epithelial detachment, RPE tear, classic and occult CNVM and disciform scar). ARMD is more common in females than males and as the age increases prevalence of disease also increases.

Age-related macular degeneration starts unilaterally and later becomes a bilateral disease and most of them have better vision at the early stages of the disease. Hence, if diagnosed early, we can prevent the progression of dry ARMD lesions into visual impairing exudative lesions. Exudative ARMD accounts for most of the cases with poor vision.

Fundus fluorescein angiography is very useful in detection of dry ARMD; in wet ARMD, it helps in identifying the early lesions like serous PED, fibrovascular PED and in established cases, it also helps to delineate the location and extent of CNVM. But, in few instances, there is difficulty in identifying the CNVM due to either diffuse blocked fluorescence or pooling of the dye in FFA there by obscuring the underlying pathology. Three-dimensional imaging technique, Optical Coherence Tomography is highly sensitive and specific in identifying the extent, location and activity of CNVM, but it is less sensitive in diagnosing dry ARMD.

Though, Fundus Fluorescein Angiography is the gold standard procedure for screening ARMD and detection of dry ARMD, but OCT is more specific diagnostic tool in detecting early subretinal neovascular membrane and also to assess the extent, location and activity of the neovascular membranes. Hence, OCT is better diagnostic tool than FFA in diagnosing early wet ARMD and thus helps in early management of patients with ARMD and thereby preventing severe visual loss due to ARMD.

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