884 The Angiographic Phases of ICG-A As a Basis for Clinical Interpretation

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Objective

Describe and compare the 'standard'phases of choroidal indocyanine green angiography with the standard phases of retinal fluorescein angiography in a variety of disease states.

Methods

The fundus camera-based digital angiograms of 27 consecutive patients who underwent concurrent fluorescein angiography (FA) and pulse[1] indocyanine green angiography (ICGA) were reviewed and evaluated by two retina specialists and one ophthalmic photographer. Normal filling phases and hypo/hyperfluorescence were identified and compared in each angiogram.

Recent literature describing ICG angiography was reviewed.[2-7]

Results

- The normal course of FA includes these phases:
  - choroidal flush (B)
  - retinal arterial filling (C)
  - retinal venous filling (D)
  - full transit (E)
  - mid recirculation (F)
  - late recirculation (G)
- The normal course of ICGAincludes these phases:
  - choroidal arterial filling (J)
  - choroidal venous filling (K)
  - retinal arterial filling (L)
  - retinal venous filling (M)
  - full transit (N)
  - mid recirculation (P)
  - late choroidal recirculation (Q)
- Similarities: normal FA & ICGAfilling phases
  - laminar flow during retinal venous filling (D,M)
- Differences:normal FA & ICGAfilling phases
  - choroidal arterial and venous filling phases can be distinguished in ICGA (J,K)
  - *watershed* perfusion pattern of short posterior ciliary arteries during ICGA choroidal arterial filling phase (L)
  - *Mie effect* (additive forward scatter) during ICG full transit phase (O)
  - Optic nerve in late phase FA is *bright*; in late phase ICGAit is *dark*. (G, Q)

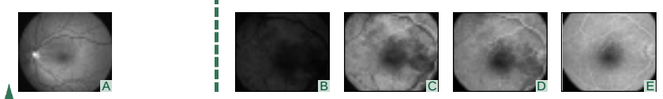
Pre-injection
Retina
Green filter: Dark retinal vessels on medium grey background (A)

Choroid
Evident in lightly pigmented individuals

Transit (0-30 sec.)
Retina
10-15 sec:cilioretinal arteries fill
12-17 sec.: arteries fill (C)
25 sec.: veins fill (laminar flow) (D)
30 sec.: veins full, arteries emptying (E)
Choroid
10-15 sec. Patchy, irregular filling of choriocapillaris (B)
30 sec.: brightest choroidal phase (E)

Early Recirculation (1-5 min.)
Retina
Dye clearing (F)
Reduction of contrast & detail
Choroid
Dye clearing
Decreasing background fluorescence

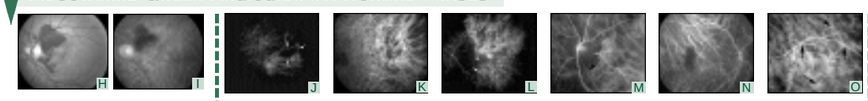
Mid Recirculation (6-12 min.)
Retina
Further loss of contrast (G)
disc staining increases
Choroid
Dye clearing
Decreasing background fluorescence



Fluorescein Angiography: Normal Phases

Time

Indocyanine Green Angiography: Normal Phases[2]



Pre-injection
Retina
Green: Dark retinal vessels on medium grey background (H)

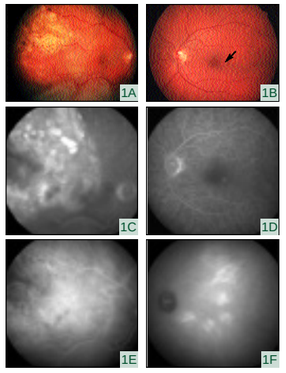
Choroid
Red: Light retinal & choroidal blood vessels (I)

Transit (0-30 sec.)
Retina
12-17 sec.: arteries fill
25 sec.: veins fill (laminar flow) (M)
Choroid
0-15 sec.: medium sized choroidal arteries fill, lobules: dark, unfilled areas (J)
12-17 sec.: med. arteries &veins fill (K), 'watershed'perfusion may be seen (L)
30 sec.: brightest images & highest contrast (N),
'Mie effect'(additive forward scatter) appreciated (O)

Mid Recirculation (6-12 min.)
Retina
Dye clearing
Reduction of contrast & detail
Choroid
General isofluorescence (P)

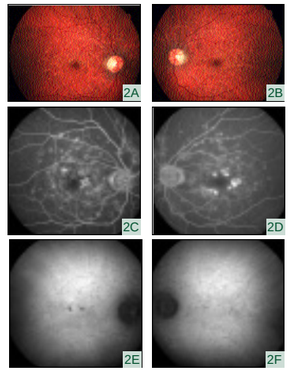
Late Recirculation (17-40 min.)
Retina
Retinal vessels difficult to distinguish
Disc is black and featureless
Choroid
Med. size choroidal vessels seen in relief against background of extravascular choroidal fluorescence (Q)

Indocyanine Green and Fluorescein Angiography: Clinical Examples



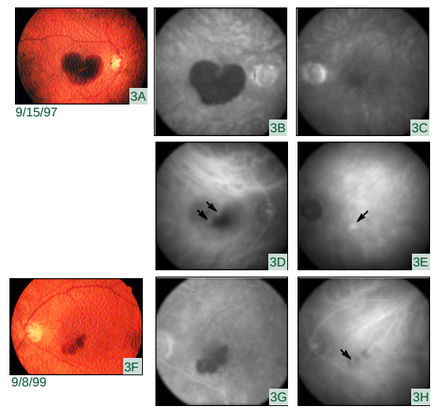
Case 1 48 Y.O.Female with V.A. OD HM/ OS 20/25

1A OD:exudative retinal detachment with subretinal mass[3]
1B OS:small RPRdetachment *(arrow)*
1C FA OD:multifocal RPEleakage, dye pooling
1D FA OS: subtle RPEtransmission defect
1E ICGAOD: diffuse hyperfluorescence of choroidal mass
1F ICGAOS: multiple discrete hyperfluorescent choroidal foci *undetected* on FA or clinical exam



Case 2 47 Y.O.Female with V.A. OU 20/20

2A/2B Stargardts/Fundus Flavimaculatus[4]
2C/2D FA: Bilaterally symmetrical, foveal sparing, multifocal, pisciform areas of discrete macular hyperfluorescence
2E/2F ICGA: multifocal reticulated areas of choroidal hypofluorescence with scattered punctate hyperfluorescent dots



9/15/97

9/8/99

Case 3 79 Y.O.Female VA OD 20/400; OS 20/30 Age Related Macular Degeneration[5,6]

9/15/97
3A OD: subretinal hemorrhage obscuring macular detail
3B FA OD: ill defined hyperflourescence obscured by blood
3C FA OS: drusen without increasing hyperflourescence
3D ICGAOD: hyperfluorescent foci of presumed CNVM *(arrow)*
3E ICGAOS: discrete hyperfluorescent macular lesion *(arrow)*

9/8/99
3F OS: fresh macular subretinal hemorrhage
3G OS FA: vague ill defined hyperfluorescence
3H OS ICGA: focal discrete hyperfluorescence underlying new hemorrhage; *localized to prior (3E) area of choroidal ICG hyperfluorescence (arrow)*

Discussion

The accurate interpretation of clinically relevant characteristics in FA and ICGArequires recognition of the fundamental fluid dynamics and the biophysical properties of these two dyes (clinical cases #1, #2).

The normal phases of FA are characterized by the hemodynamics of fluorescein dye movement through the retinal vasculature, with minimal contribution by rapidly dissipating dye in the choroidal vasculature.

Normal phases of ICGAare characterized by the hemodynamics of ICG dye movement through the retinal vessels, the choroidal and choriocapillaris vascular beds, and the prominent retention of the ICG dye within the choroidal vasculature.

Case #3 is an example of hyperfluorescence which can be appreciated in both late phase FA and ICGAphotographs of CNVM. The FA represents accumulating hyperfluorescence from leakage, while the ICGAhyperfluorescence represents an accumulation of protein bound ICG dye.

Familiarity with the standard phases of FA and ICGAencourages clinical interpretation based on the underlying histopathological and structural alterations in diseased ocular tissue.

Conclusions

- Vessel filling in both the choroidal and retinal circulations can be identified on ICGA, while the normal phases of FA describe retinal filling patterns only.
- Normal and abnormal hypo/hyperfluorescent angiographic patterns familiar to retinal specialists during the interpretation of FA differ from the hypo/hyperfluorescent patterns found during ICGA.
- Heightened recognition of the spectrum of normal ICGA characteristics during interpretation is encouraged.

References

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