University of Wisconsin
SCHOOL OF MEDICINE
AND PUBLIC HEALTH

Fundus Photograph Reading Center

Standard Fluorescein Angiography (FA-D)

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Table of Contents

1. FA-D Overview

This document details the Fundus Photograph Reading Center (FPRC) procedure for photographer certification, provides instructions to image the Standard Fluorescein Angiogram (FA-D), and offers pointers on imaging technique.

This document also provides information and references for digital system certification. Digital systems must be certified for each study separately. See the *Digital System Certification* document for further details.

Further clarification regarding any information included in this document may be obtained by contacting the FPRC Imaging staff at (608) 410-0619 or by sending an email to Imaging_administrators@rc.ophth.wisc.edu.

2. Photographer Certification

2.1. Overview

Photographer certification is specific to each study and photographers taking digital images for studies evaluated by the FPRC must be certified for the relevant procedure(s) before submitting actual subject images. The certification images should be taken on subjects being photographed for clinical purposes. Once a photographer is certified for a specific study, he/she is certified for the duration of that study, provided he/she meets the quality standards set by the FPRC. See section *6 Evaluation of Image Quality*.

2.2. Certification Requirements

Certification consists of:

- Review of the study synopsis/protocol and imaging procedure(s)
- The ability to perform the imaging procedure(s), demonstrated by the submission of images of acceptable quality

2.2.1. Images Required if Previously Certified

The second certification requirement listed above will be waived if all of the following criteria are met:

- The photographer has prior certification at the FPRC using **an identical procedure.**
- The photographer has been actively taking images during the past 12 months.
- The images are judged to be of good quality by the FPRC.

If a photographer thinks that these criteria have been met or that he/she has been certified by the FPRC for a similar procedure, submit a certification request (see section *2.3 Submission for Certification*) without sending images.

2.2.2. Images Required if Not Previously Certified

Submit a certification request (see section *2.3 Submission for Certification*), and send two fluorescein angiograms taken using this procedure (FA-D).

2.3. Submission for Certification

Photographers are encouraged to send complete submissions for each procedure for which they are requesting certification (i.e., if two angiograms are required for a certification submission, send both angiograms together)

Photographers who meet certification criteria will receive confirmation of certification. Those who do not meet these criteria will receive feedback from the FPRC Imaging consultants and may be required to submit additional sets of images. A plan for improving image quality may be necessary after three complete unsuccessful certification submissions.

2.4. Uncertified Photographers

2.4.1. Baseline/Screening Visits

Only FPRC-certified photographers are allowed to take baseline (screening visit) photos, unless an exception to this rule is granted (on a case-by-case basis) by the study sponsor. The baseline images for a subject are critical since all follow-up measurements are compared to this point to determine the study outcome.

The sponsor may suspend subject enrollment if the site does not have a certified photographer available to take the baseline images.

2.4.2. Follow-up Visits

On rare occasions during **follow-up** visits ONLY, when a certified photographer is not available, an uncertified photographer familiar with the procedure(s) may take the images. The uncertified photographer should review the imaging procedure(s) before performing photography to be certain he/she understands the procedure and follows the study requirements. Include a comment with the submission or any official documentation indicating that the images were taken by an uncertified photographer and the reason why.

3. Imaging Devices

Retinal devices suitable for this procedure will have 30° or 35° magnification settings. Canon retinal camera models used at the 40° setting are also suitable. Cameras without an optical 30° or 35° magnification setting, such as the Canon CF-1 or similar cameras may be suitable but will be evaluated on a case-by-case basis. Additionally Heidelberg scanning laser devices may be used for this procedure using the 30 degree setting. Acceptable models include the HRA2® and Spectralis®. Contact the FPRC if your camera does not have a 30° or 35° magnification setting or if you have questions about the camera/device you intend to use.

4. Fluorescein Angiography Fields and Timing

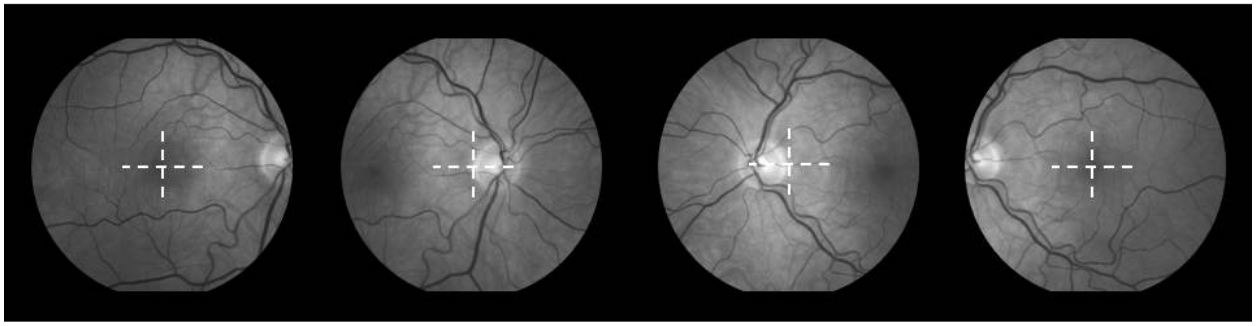
For the following descriptions of the standard fields assume that there are two cross hairs in the camera ocular, one vertical and the other horizontal, intersecting in the center of the ocular.

Field 1M- Optic Disc: Center the temporal edge of the optic disc at the intersection of the cross hairs. The optic disc will be off center, providing a partial view of the macula.

TIP: *When the optic disc is not centered in Field 1M—the center of the macula will usually be seen off to the side.*

Field 2-Macula: Center the macula near the intersection of the cross hairs in the ocular. A suitable position can often be obtained by rotating the camera temporally from the Field 1M position, without vertical adjustment being necessary.

Fields 1M and 2 of the right and left eyes are illustrated in the figure below.



Field 2 right eye *Field 1M right Eye* *Field 1M left eye* *Field 2 left eye*

Stereoscopic red-free photographs are taken of Field 2 in each eye prior to the injection of the dye. The fellow eye stereo pair should be taken first, then the study eye pair. This will ensure focus in the early phase of the angiogram is correct in the early phase photos.

The angiogram contains stereoscopic views of two fields at specified times after injection. Stereo pairs should be taken shooting the left member of the pair first, followed by the right member of the pair. This sequence should be followed throughout the angiogram.

Do not delete any images taken during the fill phase (0sec-50sec). The FPRC would prefer that all red-free images and images acquired between 1min-10min be edited to include only the required stereo pairs described in this section.

4.1. Dye Injection

After the red-free images of both eyes have been taken, the camera is positioned for Field 2 of the study eye. The dye is injected rapidly (less than 5 seconds if possible) into the antecubital or other convenient vein according to usual clinic procedures.

4.2. Angiogram Timing

After the red-free photos are taken of each eye, the photos in the angiogram should follow the timing points below. None of the photos from the start of the timer to 45 seconds should be edited. The photos from 1-10 minutes should be edited so only one good stereo pair is exported for each time point.

Timing	Study Eye (SE) or Fellow Eye (FE)	Field
Start injection = 0sec	SE	F2
Stop injection ~5sec		

Transit 15-45sec (~5-8pairs)		
60-90sec		
60-90sec	SE	F1M
2min	FE	F2
2-3min	SE	F2
5min		
10min		
10min	FE	F2

4.2.1. Early Phase

An image is taken at the moment the injection of dye begins (time "0") and another image is taken at the moment the injection is complete. These photographs are referred to as the "control" photographs. They serve to document the integrity of the interference filters (exciter and barrier). The time shown on the second frame documents the duration of injection.

Ideally, the control photographs are followed by a series of 10-16 exposures taken at 1-2 second intervals, beginning about 15 seconds after the start of injection (sooner if dye appears before 15 seconds or delaying the series if a slow circulation time is expected or the dye does not appear) to capture the earliest appearance of dye. The usual result is 5-8 stereo pairs following the control pair, typically culminating about 40-45 seconds after the start of injection. Remember not to delete any of these early phase images.

4.2.2. Mid-Phase

After the early-phase photographs are completed, the photographer takes stereo pairs of Field 2 and then of Field 1M of the study eye at approximately 60-90 seconds. Next, a stereo pair of Field 2 is taken of the fellow eye at approximately 2 minutes. Then the camera is positioned back to the study eye, and a stereo pair of Field 2 is taken between 2 and 3 minutes. Remember that the FPRC would prefer that images taken during the mid and late phases be edited to include only necessary stereo pairs.

4.2.3. Late-Phase

A stereo pair of Field 2 in the study eye is taken at 5 minutes. A final stereo pair is taken of Field 2 in both eyes at 10 minutes.

5. Submitting Study Images to the FPRC

Images should be saved using no compression or lossless compression (PNG). For additional information on specific image handling procedures, see the *Digital System Certification* document.

6. Evaluation of Image Quality

6.1. At the Study Site

The angiogram should be evaluated for quality by the principal investigator and/or photographer (unless prohibited by Study Protocol) before submission to the FPRC. If quality is not adequate for assessment of key features of the study eye (such as extent of macular edema), and if no irremediable cause of inadequate quality is present (such as lens opacities or a pupil that will not dilate adequately), the angiogram should be retaken before submission to the FPRC.

6.2. At the FPRC

Angiograms are reviewed and assigned a grade for overall quality. Feedback will be provided to the photographers as needed to help with resolution of any problems. Special attention will be given to photographers having difficulty meeting study photo quality standards. If a certified photographer consistently fails to meet study standards, certification may be suspended.

7. Pointers on Imaging Technique

7.1. General

When beginning an angiogram, the fellow eye red-free photos should be taken first, then the study eye. This will ensure focus in the FA is correct in the early phase photos. Stereo pairs should be taken consistently, shooting the left member of the pair first, followed by the right member of the pair. All images should be reviewed for quality at the time of photography, and the photographer should select the best stereo pairs for each time point after 1 minute, deleting extra images.

7.2. Patient Cooperation

Photography of the photophobic subject can be challenging for the photographer and uncomfortable for the subject. Minimizing the number of flashes and the length of time the eye is exposed to a bright viewing lamp are two things that can help make the photography procedure more comfortable. Additionally, keeping the view lamp as low as possible (maybe even dimming the room lights) can help make the photography procedure more tolerable. Patients should be asked to blink frequently to help keep the cornea clear.

If the subject has difficulty tolerating the screening visit photography procedure and the photographer thinks this will lead to a problem at follow-up visits, the situation should be discussed with the principal investigator and/or coordinator. In such cases, consideration should be given to not enrolling the subject in the study.

7.3. Focus/Clarity

The best image quality is obtained if corneas are not disturbed by prior examination with a diagnostic contact lens.

In a properly aligned digital system, the cross hairs and the retina are in focus at the same time. In these instances, constant attention must be paid to keeping the cross hairs in the camera ocular in focus when focusing on the retinal vessels. However, some digital systems are not parfocal with the eyepiece; in these cases, it is important to confirm that the image on the monitor is as sharp as possible. Proper camera-to-eye distance should be maintained to avoid haziness and artifacts.

If it is not possible to get the entire photographic field in crisp focus, the photographer should concentrate on getting the center of the field in focus, sacrificing a bit on the periphery if necessary. The photographer may need to re-focus when moving from Field 1M to Field 2.

A common problem is focusing below the surface of the retina. Images sometimes show clear focus on the bottom of the optic nerve cup, while the retinal surface is slightly out of focus. Primary focus should be on fine retinal vessels near the fovea. It may help to err on the side of focusing slightly above the retina rather than too deep. This should keep both the anterior surface of the retina and the pigment epithelial background in focus. Such a strategy is more important when macular edema is present.

7.4. Stereoscopic Effect

Dilation of the pupil to at least 6mm is important to permit good quality stereo photography. If the pupils cannot be dilated to at least 4mm for the screening visit, the stereo effect will be minimal or nonexistent.

The technique described by Allen[1] is used for taking non-simultaneous stereo fundus images. The camera **should not be rotated or pivoted between members of the stereo pair**; instead, it should be moved laterally from left to right with the joystick (or by sliding the camera base on its table, if preferred). Try to obtain about 2mm as the minimum separation between members of the stereo pair when moving the joystick or sliding the camera.

Stereo pairs should be taken shooting the left member of the pair first, followed by the right member of the pair. When obtaining stereo pairs, care should be taken that at least one member of the pair is of good technical quality with crisp focus. In many cases, it will be possible to obtain good quality in both members of the pair, but if this is not the case, the aim should be to obtain good quality in one member and some stereo separation between the members, accepting somewhat poorer quality in the second member of the pair, if necessary.

7.5. Exposure, Gain, and Flash

It is important that photographers adjust flash, gain, and gamma to obtain optimal exposure, as well as avoiding severe over or under exposure. Over exposure is more damaging than under exposure often resulting in total loss of image detail. We recommend that photographers become familiar with using the camera and software controls available

[1] Allen L. Ocular fundus photography. *Am J Ophthalmol* 1964; 57:13-28.

to ensure optimal exposure and good contrast. The most commonly occurring problem is exposure which is too low. The FPRC Imaging staff is available to assist in recommending acceptable settings.

Most digital systems have a wide variety of image enhancement tools to adjust image contrast, brightness, or sharpness after image capture. Enhancement tools should not be used at the clinical site to adjust image quality. Pay careful attention to obtaining optimum exposure and image sharpness so that enhancements are not necessary.

8. References

Early Treatment Diabetic Retinopathy Study Research Group, Manual of Operations. Chapter 13. Baltimore: ETDRS Coordinating Center, University of Maryland. Available from: National Technical Information Service, 52285 Port Royal Road, Springfield, VA 22161; Accession No. PB85 223006/AS Chapter 13.

Macular Photocoagulation Study Group, Macular Photocoagulation Study: Manual of Procedures. MPS Coordinating Center, Baltimore, MD. Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; Accession No. PB90-207903.

Age Related Eye Diseases Research Group, Manual of Operations. Chapter 8. Potomac, MD: AREDS Coordinating Center, EMMES Corporation, 11325 Seven Locks Road, Suite 214, Potomac, MD 20854.