Comparison of Ultra-Widefield Imaging and Standard Imaging in Assessment of Early Treatment Diabetic Retinopathy Severity Scale

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Purpose: To compare Early Treatment Diabetic Retinopathy Study (ETDRS) severity levels between standard 7-field imaging and ultra-widefield (UWF) imaging and to incorporate peripheral diabetic retinopathy (DR) lesions into the ETDRS grading system.

Design: Cross-sectional Study.

Participants: Paired images from 192 eyes (189 participants) with diabetic retinopathy were included.

Methods: The ETDRS levels were determined by masked graders in 3 ways: standard 7-field imaging, UWF within the 7-field region (7-field UWF imaging), and the entire UWF image (global ETDRS imaging).

Main Outcome Measures: Percentage agreement between 7-field and UWF imaging for ETDRS levels.

Results: Of the 166 paired images evaluated, exact agreement was found in 48.8% of eyes between standard 7-field and 7-field UWF ETDRS levels with a weighted κ value of 0.59 (95% confidence interval [CI], 0.5−0.68). Agreement rates varied with DR severity and were least in early DR (30.8%) and moderate non-proliferative DR (26.5%) groups. In 156 eyes with 7-field UWF ETDRS and global UWF ETDRS levels, exact agreement was found in 143 eyes (92%), with a weighted κ value of 0.9 (95% CI, 0.9−0.98). The peripheral lesions contributed to a higher DR severity in 8% and changed the eye to a proliferative DR level in 2%. Reproducibility of the 3 ETDRS evaluations was comparable with a weighted κ value of 0.57 with standard 7-field imaging, 0.65 with 7-field UWF imaging, and 0.60 with global ETDRS scale imaging.

Conclusions: Moderate agreement was found in the ETDRS DR severity scale between standard 7-field and UWF imaging, indicating caution in interchanging data from the 2 methods. Both methods showed good reproducibility for clinical trial outcome of 2-step change. The global ETDRS scale provides a comprehensive score to incorporate peripheral changes into the ETDRS scale. The implications of the global scale on progression rate are yet to be determined. *Ophthalmology Science 2021;1:100029 © 2021 by the American Academy of Ophthalmology. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).*

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Photographic documentation of the retina has been in use for more than a century as a tool for both clinical care and research for patients with retinal diseases.[1] Development of severity scales, particularly for diabetic retinopathy (DR), required a standardized imaging protocol. During the Diabetic Retinopathy Study in 1969, additional fields were added to the existing 4-field imaging protocol to incorporate posterior pole changes into the severity scales.[2,3] The Diabetic Retinopathy Study established a 7-field imaging protocol with the option of capturing an additional peripheral field if the most severe retinal new vessels were outside of the 7 fields. The evolution of the imaging protocols depicts the limitation of the camera systems in capturing peripheral retina in the early 1970s. Development of widefield cameras expanded the retinal view from 30° to 45° to 60° and helped to reduce the number of images required to image the 7-field region. The 4-wide imaging protocol returned into favor in

approximately 2000 and was found to be equivalent to 7-field imaging in evaluation of DR.[4] Over time, the 7-field and 4-wide imaging protocols continued to be the gold standard for assessment of DR using the Early Treatment Diabetic Retinopathy Study (ETDRS) severity scale.

The recent introduction of ultra-widefield (UWF) imaging systems has enabled imaging of the posterior retina and much of the peripheral retina in a single capture. The Optos ultra-wide camera (Optos PLC) uses scanning laser ophthalmoscopy to image 200° of the retina in a single image. Peripheral retinal changes in eyes with DR have been studied using the Optos camera.[5−9] Diabetic retinopathy lesions in the periphery were seen in one third of eyes, mostly temporally, and the frequency varied with severity of DR. Studies also have compared and shown good agreement for the DR severity assessment between the 7-field images and the equivalent area on an UWF image.[5,7,8,10,11]

However, most studies did not use the complete ETDRS scale for comparison, either relying on the abbreviated International Classification of Diabetic Retinopathy scale or a collapsed version of the ETDRS scale.[5,8,10] In drug trials, the United States Food and Drug Administration requires a 2-step change on the ETDRS scale as an outcome.[12] This usually is performed at reading centers by trained and certified graders using a double read with adjudication method.

The ease and advantage of imaging a single-capture UWF image over a standard 7-field, 4-wide imaging protocol requiring multiple images is evident. Studies carried out thus far have shown that DR severity is worse in eyes in which peripheral diabetic lesions are more numerous than lesions within the standard 7 fields. The purpose of this cross-sectional study was 2-fold: (1) to compare the ETDRS severity level between standard 7-field imaging and UWF imaging using the ETDRS scale and (2) to demonstrate extension of the ETDRS grading protocol to the peripheral retina using a global ETDRS scale.

Methods

Treatment-naïve patients with DR from a large de-identified dataset at the University of Wisconsin Fundus Photograph Reading Center were included in this cross-sectional comparative study. Paired Optos UWF and 7-field, 4-wide stereoscopic color photographs were selected randomly within each DR strata to include at least 10 eyes in every ETDRS severity level. The research adhered to the principles of the Declaration of Helsinki and the Health Insurance Portability and Accountability Act of 1996. Institutional review board approval was granted by the University of Wisconsin, and written informed consent was obtained from all participants.

Imaging Protocol

Standard 7-Field, 4-Wide Imaging Protocol. The field of view captured in each of these methods has been described in detail elsewhere.[4] In brief, cameras with 30° or 35° magnification were used for the stereoscopic 7-field protocol to provide 3 fields of the disc and macula and 4 fields of the peripheral retina. For the stereoscopic 4-wide imaging protocol, 45° to 60° magnification was used to obtain 2 fields of the disc and macula and 2 widefield views covering the peripheral fields. All images were acquired by certified photographers using standard image acquisition guidelines.

Optos Ultra-Widefield Imaging Protocol. Images were acquired using the Optos California systems (P200 MA or P200 DTX). Two on-axis 200° color Optomap images were obtained. These were paired images and were not obtained stereoscopically. Photographers were asked to review images to ensure that the disc and macula were visible clearly, with clear visualization of the retina out to the vortex veins. Lid and lash artifacts were to be minimized to obscure less than 10° of the field of view. All images were acquired by certified photographers using standard image acquisition guidelines.

Grading Protocol

All images were graded independently by 2 masked evaluators with more than 10 years of experience in grading DR and were assigned an ETDRS level. Eyes with a disagreement of 1 or more steps on the ETDRS scale were adjudicated by a senior grader (N.B.). A gap of at least 3 weeks occurred between evaluation of 7-field, 4-wide images and UWF images. In all cases, the UWF images were evaluated after the 7-field, 4-wide images.

Standard 7-Field Grading Protocol. The standard 7-field image assessment followed the ETDRS method of evaluation in which DR lesions are identified from stereoscopic color photographs and the most severe of the lesions is compared with a set of standard photographs to arrive at a severity level. The ETDRS scale is a categorical alphanumeric scale with 16 levels ranging from 10 through 85. The ETDRS levels then are assigned a recoded ETDRS step value to convert the alphanumeric levels into a linear version for statistical analysis (Supplemental Table 1). A change of 2 steps or more in the ETDRS scale of each eye is considered an outcome for most DR studies.[12] Agreement between graders was assessed as exact agreement, 1-step agreement, and 2-step agreement with weighted κ values.[13]

In the standard 7-field imaging protocol, when determining the DR severity level, if 2 or more peripheral fields are missing or have less than 50% of the field determined gradable, the DR severity level given is 90 (cannot grade). However, the DR severity level is evaluated if it is determined that a definite proliferative lesion(s) ($\geq$ level 61A) is present in a gradable or ungradable field.

Optos Ultra-Widefield Grading Protocol. The Optos Advance software (Optos PLC), available since 2018, provides grids and automatic calibration to account for peripheral warping. The grading has 2 stages: the 7-field ETDRS level and the global ETDRS level. The 7-field ETDRS level involves using a single nonstereoscopic masked color image in which a masking tool reveals only the 7-field region of the UWF image and blacks out the periphery.[8] The ETDRS levels within the 7-field region are assigned using the same method as the standard 7-field protocol.

After the 7-field ETDRS level is assigned, the mask is removed and replaced with a grid outlining the standard 7 fields and 5 peripheral regions (which are extensions of the 7 fields).[8] The grader then applies the same ETDRS method of grading used in the standard 7-field image comparing each peripheral field with a standard photograph to assess the global ETDRS level. Each temporal peripheral region is equivalent to 1 additional 30° field (area in square millimeters), and each nasal peripheral region area is equivalent to 2 30° fields (Fig 1). Graders are permitted to use image optimization tools such as brightness, contrast, color channels, and magnification restricted to ×2 to assist in evaluation.

With 7-field ETDRS level as a starting point, the periphery is assessed for potential DR lesions that could worsen (raise) the severity level. Each peripheral field is compared with standard photographs to determine the severity of lesions present and if these lesions add to the predesignated 7-field ETDRS scale. The periphery can contribute to the 7-field ETDRS severity level in 2 ways: either an increase in severity of lesions identical to those in the 7-field region or new lesions within the periphery that are not visible in the 7-field region. For example, in scenario 1, an eye with hemorrhages of standard photograph 2A or more in a single field is assigned a 7-field ETDRS level of 43. If a peripheral field adds an equivalent amount of hemorrhage, that will constitute 2 fields of hemorrhage of standard photograph 2A or more in the eye, and the global ETDRS level becomes level 47. Scenario 2 is a case with new vessels visible only in the peripheral retina beyond the 7-field area. With the ETDRS level as a starting point, the global level cannot be better (lower) than the 7-field UWF ETDRS level.

For UWF image grading, when determining the presence or absence of DR lesions in the UWF peripheral fields, at least 4 far-peripheral fields must be present and of sufficient quality for evaluation. If 2 or more far-peripheral fields are missing or have less than 50% of the field determined gradable, the lesion cannot be graded, and a response of "cannot grade" is entered for that lesion in the periphery.
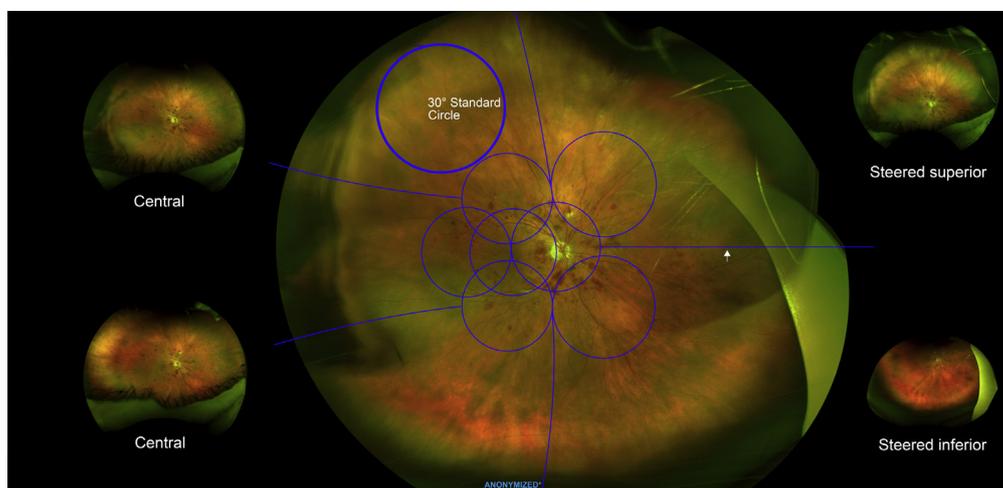
Figure 1. Optos ultra-widefield montage image with 7-field outline grid and 5 peripheral fields. The 30° standard circle represents the area of a single 30° image. Each temporal peripheral region has an area equivalent to 1 additional 30° field, and each nasal peripheral region area is equivalent to 2 30° fields. The study used 2 central images only. Current protocols include 2 additional steered views superiorly and inferiorly to give a complete view of the periphery, as shown in the montage. Montages are not used for grading.

Special Considerations for Evaluating Lesions in the Periphery

Within the 7-field area of an UWF image, DR lesions are graded exactly as they are with 7-field and 4-wide images. Outside of the 7-field area, graders address DR lesions with a slightly different approach. For lesions requiring an area estimation in the periphery (e.g., new vessels, preretinal and vitreous hemorrhage), the graders are aware of the distortion of the retina in the far periphery. Image calibration in Optos Advance is particularly useful to estimate area of lesion. Second, vascular lesions such as venous beading can be difficult to grade confidently in the periphery of UWF images. Because the periphery is distorted when the image is projected, the natural paths of the vessels can be shifted, making a vessel appear to widen and then narrow again. Finally, the retinal periphery can have various changes that typically are not seen in the macula, for example, reticular pigment, unusual vascular patterns, and myopic changes.[14] These lesions can be seen in a healthy population and are not graded.

Statistical Analysis

The ETDRS levels are categorical variables and were summarized as percentages. Comparison of ETDRS levels between methods and between graders was carried out using percentage agreement and weighted κ value. Weights were assigned as 1 for exact agreement, 0.75 for 1-step disagreement, and 0 for all other disagreement.[15]

Results

Paired standard 7-field and UWF images of 192 eyes were evaluated for ETDRS DR severity level. Of these, 3 eyes were considered ungradable using standard 7-field images and 24 eyes were considered ungradable using UWF images. Distribution of standard 7-field ETDRS level, masked 7-field UWF ETDRS level, and global ETDRS level is shown in Table 1.

Of the 166 gradable pairs, the standard 7-field ETDRS level and 7-field UWF ETDRS level showed exact agreement in 81 eyes (48.8%), within 1 step in 141 eyes (84.9%) and within 2 steps in 155 eyes (93.4%) (weighted κ, 0.59; 95% confidence interval [CI], 0.5–0.68; Fig 2). Of the 85 eyes (51.2%) with disagreement between the 2 methods, 53 eyes (62.3%) were given a less severe ETDRS level on UWF and 32 eyes (37.6%) were given a more severe ETDRS level on UWF compared with standard 7-field imaging. Six eyes were classified as having proliferative DR (PDR) on standard 7-field imaging and classified as having nonproliferative (NPDR) on UWF, and 7 eyes were classified as vice versa. Although the overall agreement was 48.8%, the variability in agreement rates with each severity level is shown in the bar graphs in Figure 3 with least agreement in the early DR and moderate NPDR groups.

Although standard imaging is referred to as standard 7-field imaging, the dataset consisted of both 7-field (n = 137) and 4-wide (n = 29) imaging. An analysis of the 2 subsets showed no differences in the agreements. Comparing 7-field standard 7-field ETDRS level and 7-field UWF ETDRS level showed exact agreement in 67 (49%) eyes, within 1 step in 116 (84.7%), and within 2 steps in 128 (93.4%; weighted κ, 0.59; 95% CI, 0.49–0.69). Comparing 4-wide standard ETDRS level and 7-field UWF ETDRS level showed exact agreement in 14 (48%) eyes, within 1 step in 25 (86.2%), and within 2 steps in 27 (93.1%; weighted κ, 0.49; 95% CI, 0.27–0.72).

In 156 eyes with 7-field UWF ETDRS scale and global UWF ETDRS scale, comparison between the 2 scales showed exact agreement in 143 eyes (92%; weighted κ, 0.9; 95% CI, 0.9–0.98; Fig 4). In 10 eyes (6.4%), the ETDRS level increased by 1 step on the global scale compared with 7-field imaging and in 3 eyes (2%) by 2 steps or more. The ETDRS level changed from NPDR in 7-field imaging to PDR on global imaging in 2 eyes (1%).

Reproducibility of the ETDRS scale within each imaging method also was assessed, because all images went through a double-read with adjudication (Table 2). Intergrader agreement with the 7-field, 4-wide method was 54% exact

Table 1. Frequency Distribution of Diabetic Retinopathy Severity Levels Using Standard 7-Field, Ultra-Widefield 7-Field, and Ultra-Widefield Global Early Treatment Diabetic Retinopathy Study Severity Grading Methods (n = 192)

Diabetic Retinopathy Severity	ETDRS Severity Step	ETDRS Severity Level	Standard 7-Field	Ultra-Widefield Masked 7-Field	Ultra-Widefield Global
No or early DR	1, 2	10, 12, 14, 15, 20	15 (8%)	6 (3%)	6 (3%)
Mild NPDR	3	35 A−F	27 (14%)	51 (27%)	42 (22%)
Moderate NPDR	4	43 A−B	38(20%)	32 (17%)	31 (16%)
Moderately severe NPDR	5	47 A−D	67(35%)	39 (20%)	36 (19%)
Severe NPDR	6	53 A−E	12 (6%)	19 (10%)	20 (10%)
Proliferative DR	7−12	60, 61A−B, 65A−C, 71 A−D, 75, 81, 85A−B	30 (16%)	21 (11%)	21 (11%)
Ungradable	90	90	3 (2%)	24 (13%)	36 (19%)

DR = diabetic retinopathy; ETDRS = Early Treatment Diabetic Retinopathy Study; NPDR = nonproliferative diabetic retinopathy.

agreement and 82% within 1 step (weighted κ, 0.57). Intergrader agreement on the 7-field UWF ETDRS level was 55% exact agreement and 85.9% within 1 step (weighted κ, 0.65). Intergrader agreement on the global ETDRS level was 55% exact agreement and 78.1% within 1 step (weighted κ, 0.6).

Discussion

In this stratified DR dataset of paired standard 7-field and UWF images evaluated for ETDRS level by certified graders, comparison between the 2 methods using the ETDRS scale showed an agreement of 48.8%, with

weighted κ values indicating moderate agreement. Considering that 2-step change is an important outcome in clinical trials, reproducibility of the grading using inter-grader agreement within 2 steps was more than 90% for both standard 7-field and UWF 7-field grading, indicating that both methods are equally usable for this outcome. Studies of alternate methods involve both comparison with a gold standard and assessment of reproducibility of the new method.[16] The reproducibility of ETDRS grading with an UWF 7-field grid is equivalent to standard 7-field imaging, indicating that ETDRS severity level assessment can be performed within the 7-field region of UWF images. However, comparison between the 2 methods shows moderate agreement, which indicates caution in interchanging the imaging methods in clinical trials or patient care.

Comparison of Standard 7-Field with Ultra-Widefield 7-Field Imaging

Agreement in ETDRS level between the 2 methods within the 7-field ETDRS region is approximately 50% overall, with a weighted κ value of 0.59. This is identical to a large comparison study performed by Aiello et al[8] for the Diabetic Retinopathy Clinical Research Network in which 764 eyes were compared using a collapsed ETDRS scale. In this study, agreement rates were exact in 48.8%, with a weighted κ value of 0.51. Many disagreements were seen, with eyes labeled as having mild or moderate NPDR on standard 7-field imaging being graded at a higher level (moderate or severe) in UWF imaging. The difficulty in agreement at these severity levels also was seen in our dataset: in absent or early DR, exact agreement was 31%, and in moderate NPDR, exact agreement was 26.5%. In eyes with absent or early DR, the trend is toward a higher level with UWF grading. Of the 13 eyes considered to have mild disease on standard 7-field imaging, 10 eyes were labeled as having more than mild disease with UWF, an important distinction elevating an eye to a referral status in teleophthalmology. The higher referral rate with UWF imaging also was found in a large teleophthalmology study by Silva et al[17] comparing nonmydriatic multifield imaging with UWF, where referral rates doubled with UWF imaging.
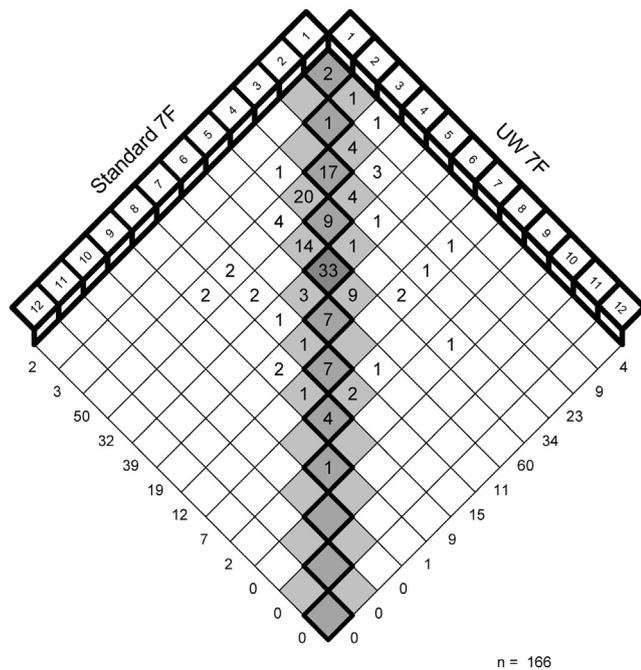

Figure 2. Cross-tabulation showing agreement in Early Treatment Diabetic Retinopathy Study levels evaluated with standard 7-field (7F) images and ultra-widefield (UWF) images within the 7-field region. Exact, 1-step, and 2-step agreements were 49%, 84.9%, and 93.4%, respectively, with a weighted κ value of 0.59
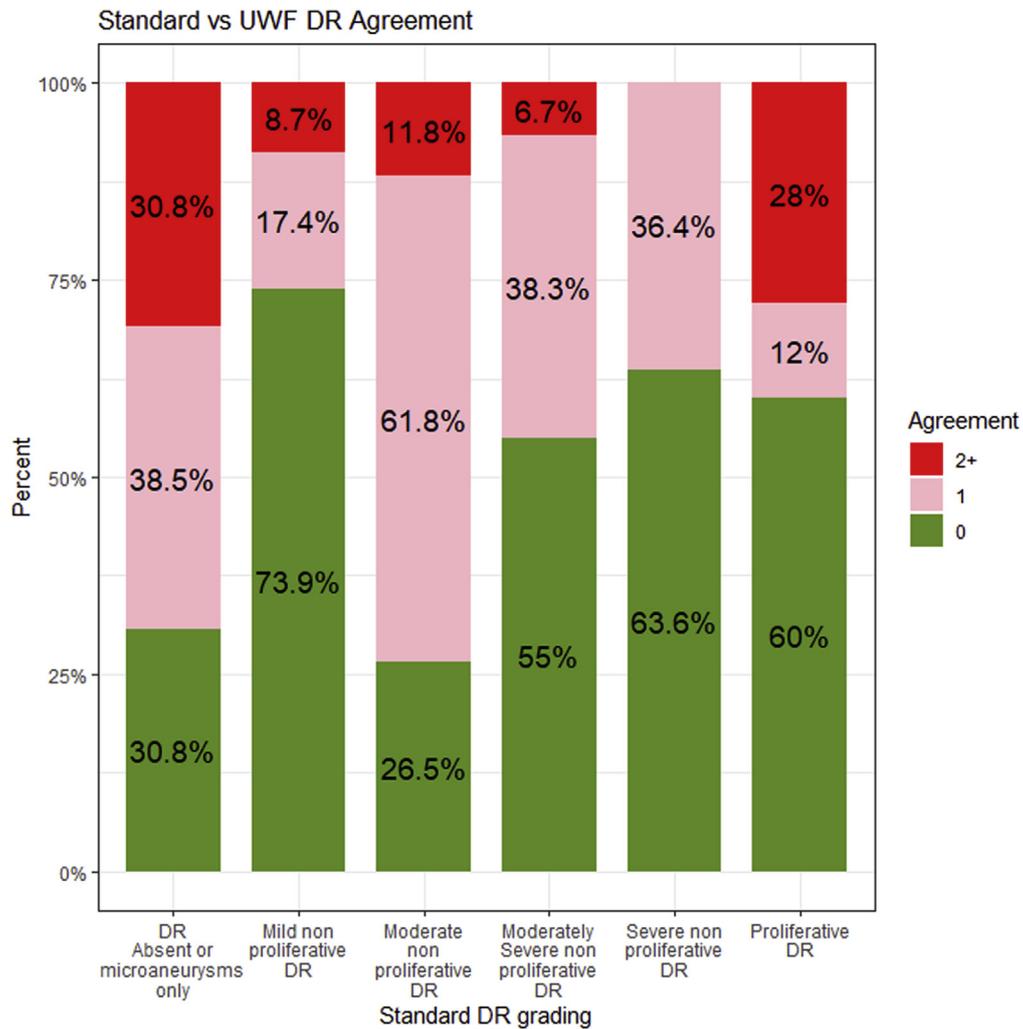
Figure 3. Stacked bar chart showing varying levels of agreement depending on diabetic retinopathy (DR) severity level. Green indicates complete agreement, pink indicates agreement within 1-step agreement, and red indicates agreement of 2 steps or more. UWF = ultra-widefield.

A post hoc review of these images was performed to understand the reasons for disagreement. In eyes with early DR, hemorrhages were detected better on UWF images. Red saturation in standard 7-field images made detection of isolated hemorrhages difficult in eyes with early DR. The second area of disagreement was in eyes with moderate NPDR. Of 34 eyes labeled as having moderate NPDR on standard 7-field imaging, 20 were classified as having mild DR on UWF because of difficulty in detection of intraretinal microvascular abnormalities (IRMAs) on UWF images. The ETDRS levels 43 through 47 (step 4−6, moderate to moderately severe) rely heavily on detection of IRMAs, and their absence in a field could imply a step change. Another interesting variability is in the detection of new vessels elsewhere: UWF did not detect new vessels in 10 eyes and standard 7-field imaging did not detect new vessels in 6 eyes, all within the 7-field region. Focus, clarity, and stereo are essential for new vessels elsewhere identification, particularly small areas of new vessels elsewhere, and lack of stereo gives UWF a disadvantage. The advantage of UWF imaging is a consistent view of the 7-field region without the edge artifacts seen in standard 7-field imaging. A montage of individual standard 7-field images would not necessarily align with the 7-field region of the UWF because of variability in a technician's identification of field of view.

Global Early Treatment Diabetic Retinopathy Study Levels

A secondary goal of this study was to identify the impact of peripheral lesions on ETDRS levels. Previous studies have approached this issue by identification of predominantly peripheral lesions.[5,8,17] We extended the ETDRS grading method to the entire UWF image, calling this the global ETDRS scale. Graders identified lesions within the periphery using areas equivalent to ETDRS standard photographs. This gave graders the required tools to assess peripheral lesions with reference to the standard photographs, a fundamental principle of the ETDRS grading method. Intergrader agreement on the UWF global scale was equivalent to the masked UWF 7-field grading, suggesting that this method can be used in clinical trials.
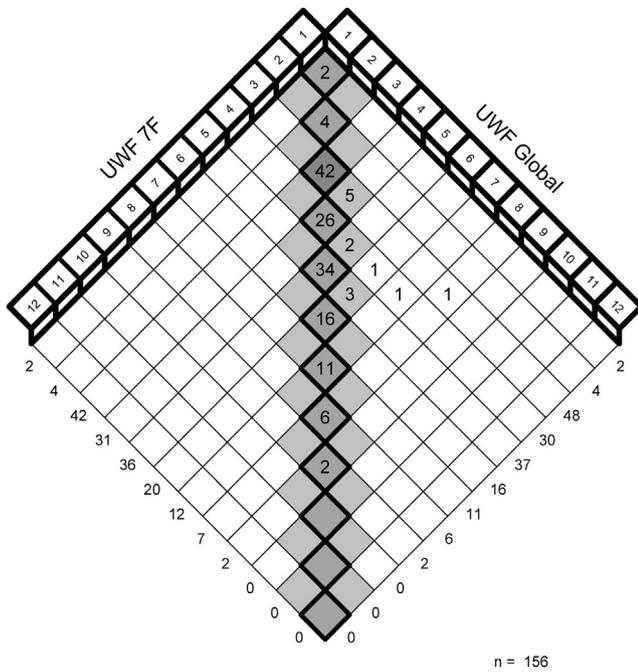
Figure 4. Cross-tabulation showing agreement in Early Treatment Diabetic Retinopathy Study levels evaluated with ultra-widefield (UWF) images within the 7-field (7F) region and the entire UWF image including the area outside the 7 fields (UWF global). Exact, 1-step, and 2-step agreements were 92%, 98.1%, and 98.7%, respectively, with a weighted κ value of 0.94

Rather than detailing presence of each lesion in retinal periphery, the global scale provides a comprehensive score on the effect of peripheral lesions on 7-field ETDRS level. This is particularly useful for assessment of DR severity with artificial intelligence algorithms and in tele-ophthalmology, where grids and masks cannot be used and DR severity is assessed using the entire UWF image. Peripheral lesions increased the severity of the ETDRS level in 9% to 15% among various studies, which was comparable with the 8% increased severity in the present dataset.[8,10,17] In addition, peripheral new vessels changed the eye to a PDR status in 2 eyes. This low rate of peripheral new vessels has been corroborated in other studies.[5,8] Similar to the Diabetic Retinopathy Clinical Research Network study, the most common peripheral lesions accounting for the changes in ETDRS level in our study were hemorrhages.[8] The relevance of peripheral lesions on DR

progression has been described by Silva et al,[18] who reported that peripheral lesions were found to have an unadjusted odds ratio of 3.2-fold increased risk of 2-step or more DR progression over 4 years. This cross-sectional study was an attempt to extend the ETDRS grading protocol to the peripheral retina and to test its reproducibility. The implications of a global ETDRS scale on progression rates are unknown at this time.

Ungradable Images

The rate of ungradable images was higher in UWF imaging compared with standard 7-field imaging (23% vs. 2%). The ETDRS level is assigned as ungradable if 2 fields or more are missing or of poor image quality. Presence of lash artifacts and lens opacities is expected to affect the region outside the 7-field area, but in this dataset, the region within the 7-field area also was affected. It is possible that both photographer inexperience and grader expertise played a role in the high rate of ungradable images. Although the photographers were certified, the images were obtained in 2017 and 2018, when UWF imaging was relatively new. The same explanation could apply to the graders who had many years of experience and comfort level with 7-field imaging, leading to a different threshold for calling an UWF image ungradable. Changes to the imaging protocol, including steered views allowing 2 on-axis central views and 2 images steered to the superior and inferior periphery, have been applied to the UWF imaging protocol. The steered view provides additional images to lean on in case of poor quality or artifacts and reduces the ungradable rates with UWF imaging (Fig 1). In addition, steering provides a much broader view of the periphery. The Diabetic Retinopathy Clinical Research Network study used the steered imaging procedure, but restricted grading to 2 central images only.[8] Ungradable rates were comparable at 1.5% using both methods.

Reproducibility of Early Treatment Diabetic Retinopathy Study Grading

Reproducibility of grading within each imaging method is an important aspect of comparison studies. The intergrader agreement using 7-field imaging (Table 2) showed exact agreement of 54% and within 1-step change of 82%. This is identical to original ETDRS scale agreements established 30 years ago, with exact agreement of 53% and 1-step agreement of 88%, indicating the stability of ETDRS grading over the

Table 2. Intergrader Agreement of Early Treatment Diabetic Retinopathy Study Severity Level with Standard 7-Field, Ultra-Widefield 7-Field, and Ultra-Widefield Global Grading Methods (n = 192 Eyes)

	Standard 7-Field Imaging	Ultra-Widefield Masked 7-Field Imaging	Ultra-Widefield Global Imaging
Exact agreement	54%	55%	55%
Within 1-step agreement	82%	86%	78%
Within 2-step agreement	93%	92%	85%
Weighted κ	0.57 (95% CI, 0.49–0.66), moderate agreement	0.65 (95% CI, 0.57–0.73), substantial agreement	0.6 (95% CI, 0.52–0.68), substantial agreement

CI = confidence interval.

years and its usefulness for identifying 2-step change in therapeutic trials.[13] It is impressive that intergrader agreement rates with UWF imaging are comparable and slightly better (exact agreement of 55% and 1-step agreement of 86%) considering that it is a newer imaging system for the evaluators.

Strengths and Limitations

The area within the standard 7-field images is not equivalent to the "ideal" 7-field grid placed on the UWF image because of variability in field of view captured by the photographer.[8] In addition, the area of the UWF image outside the 7-field area varies across participants because of the common presence of peripheral artifacts (lids, lashes). In grading UWF images using a global ETDRS scale, we have given equal weight to lesions found in the peripheral retina versus the retina within the standard 7 fields. For example, it is not known if a peripheral IRMA carries the same prognostic value for development of PDR as IRMA within the standard 7 fields. As a result, we do not know the effect of the global ETDRS scale on disease progression. Strengths of the study include certified photographs, stringent quality checks, and experienced graders with robust quality control metrics.

To conclude, ETDRS DR severity level can be determined reliably using the 7-field area of UWF images and has the same reproducibility as standard 7-field imaging. However, variability in specific ETDRS levels exists between 7-field imaging and UWF imaging, particularly in eyes with early DR and moderate NPDR. Ultra-widefield imaging is better at identifying early DR changes, but is not as sensitive at detecting IRMA, a critical feature of moderate NPDR. The global ETDRS scale is a reproducible grading method and extends the advantage of a comprehensive scoring system outside the 7-field region. The value of the global ETDRS scale on progression rates is yet to be determined.

Acknowledgments

Footnotes and Disclosures

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