Comparison of 90° field Clarus 700 in staged-mydriatic mode and mydriatic two 45° field digital imaging in the NHS Diabetic Eye Screening

Authors: Marta H Gruszka-Goh[1,2], Anthony Vukic[1], Paul Galsworthy[1], Scott Vallance[1], Peter H Scanlon[1,3,4]

1: Gloucestershire Hospitals NHS Foundation Trust, 2: The Royal College of Ophthalmologists' National Ophthalmology Database Audit, 3: Nuffield Department of Clinical Neuroscience, University of Oxford, 4: University of Gloucestershire

Aim:

The CONCORDIA study is a project looking at the accuracy of Scanning Confocal Ophthalmoscope and Broad Line Fundus Imaging camera devices in detection of any eye disease caused by diabetes.

The over-arching objective of this work was to determine if these cameras can be used in the non-mydriatic mode, and to determine if they are cost-effective to use in the NHS Diabetic Eye Screening Programme (DESP).

Methods:

The trial participants were 1,497 individuals (2,993 eyes) aged 15 to 94 with diabetes mellitus that participated in DESP.

Zeiss Clarus 700 (SCO) images were taken before the pupils were dilated and compared to two-field 45 degrees mydriatic digital photography.

When image quality was poor or pupil size was less than 3mm, images were taken with SCO before and after dilation.

In case when the non-mydriatic images were gradable, they were used in comparison to the 45 degrees mydriatic digital images, otherwise the mydriatic image was utilised.

All images were graded by two graders with arbitration for differences of opinion by a third grader.

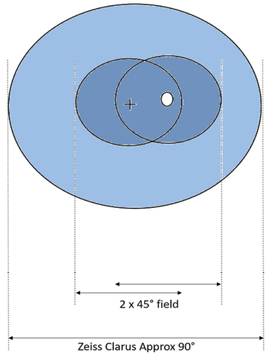


Figure 1: *Diagram of areas of images from a Zeiss Clarus 700 superimposed on the two 45-degree fields*

To compare the same areas of the eyes, SCO images were graded with two 45° field overlay and using the DESP grading criteria.

Sensitivity and specificity comparing SCO device with the reference standard were calculated for any and referable levels of DR. The ungradable pictures for both types of devices were excluded from the sensitivity, specificity, positive and negative predictive value analysis. All statistics were calculated with exact binomial confidence intervals.

Demographics:

906 (60.5%) of patients were male and 591 (39.5%) female.

Median age at the time of trial was 64.0 years with IQR (55.0-72.0) years, and was one year higher for male patients. The most frequent (31.0%) trial participants were patients aged 65 to 74 years and the least frequent (1.1%) those aged between 15 and 24 years.

Large majority (92.7%) of patients were of White Caucasian descent and proportions of individuals from another ethnic groups ranged between 0.9% and 3.1%.

Results:

57.6% of images taken with Zeiss Clarus 700 and 55.0% taken with 2-field 45° mydriatic digital photography have been graded as those with any diabetic retinopathy.

For the SCO, the sensitivity and specificity for any retinopathy were 94.2% with 95% CI (92.9% - 95.3%) and 87.3% with 95% CI (85.4% - 89.0%) respectively, Table 1 and Figure 2.

		95% CI
Sensitivity	94.2%	92.9% - 95.3%
Specificity	87.3%	85.4% - 89.0%
Positive predictive value	90.1%	88.5% - 91.5%
Negative predictive value	92.5%	90.8% - 93.9%

Table 1: *Sensitivity, specificity, positive and negative predictive values for any DR*

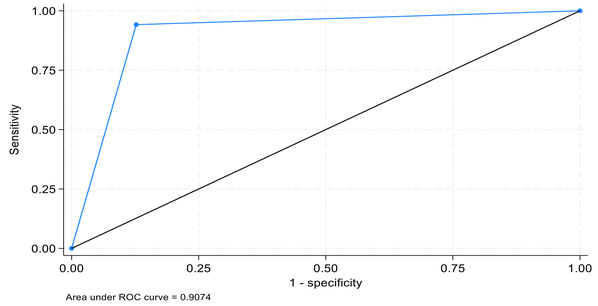


Figure 2: *ROC curve for any Diabetic Retinopathy*

22.9% of images taken with the Zeiss Clarus 700 and 20.0% taken with 2-field 45° mydriatic digital photography have been graded as those with referable diabetic retinopathy.

For the SCO, the sensitivity and specificity for referable retinopathy were 86.0% with 95% CI (82.9% - 88.8%) and 92.8% with 95% CI (91.7% - 93.8%) respectively, Table 2 and Figure 3.

		95% CI
Sensitivity	86.0%	82.9% - 88.8%
Specificity	92.8%	91.7% - 93.8%
Positive predictive value	74.9%	71.5% - 78.2%
Negative predictive value	96.4%	95.5% - 97.1%

Table 2: *Sensitivity, specificity, positive and negative predictive values for referable DR*

The difference in sensitivity of referable DR was mostly due to grading of maculopathy, where the differences were caused by:

- interpretation – 13 eyes
- varied appearance – 20 eyes
- not observed on Clarus 700 – 15 eyes
- masked by artefact – 8 eyes
- 1DD measure – 5 eyes.

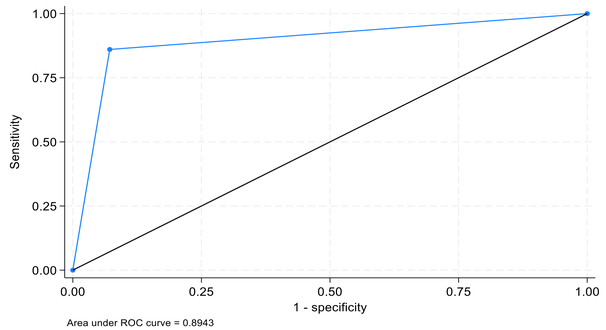


Figure 3: *ROC curve for referable Diabetic Retinopathy*

Out of 2,993 images taken in staged dilation process using Zeiss Clarus, 1.7% (n=51) with 95% CI (1.3% - 2.2%) were ungradable.

There were two ungradable images in groups aged under 35 years and the highest percentage (39.2%) of cases belonged to 65-74 age group.

35 (68.6%) of the ungradable images came from patients aged 65 and over 65 years old, Figure 4.

The highest percentage of the ungradable eyes came from the age groups under 25 years (5.9%) and 75-84 years (3.1%), Figure 5.

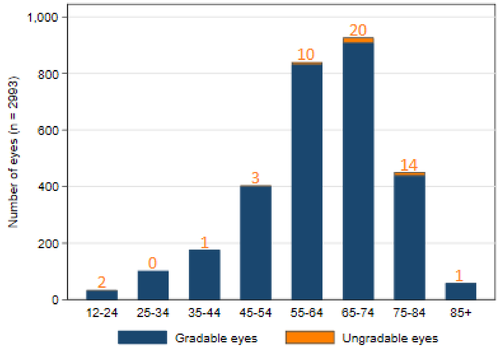


Figure 4: *Age distribution of all study eyes by gradable status*

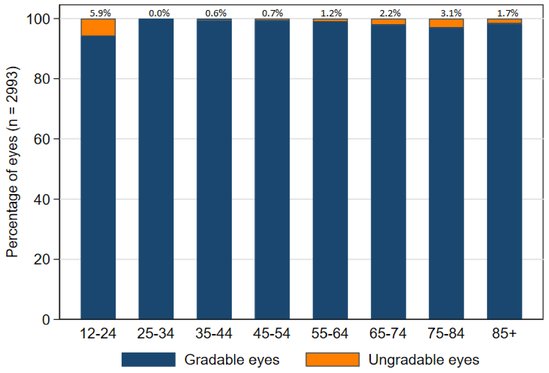


Figure 5: *Percentage of gradable and ungradable eyes by the age group for staged-mydriasis Zeiss Clarus*

The microaneurysm (MA) count was defined as non-inferior, when the number of microaneurysms detected within 1DD of the centre of the fovea on images taken using the SCO was equal to or higher than on the images taken using two 45° field digital cameras.

For staged-mydriasis images taken with Zeiss Clarus 700, in 91.2% with 95% CI (90.0% - 92.1%) of cases SCO MA count was non-inferior to the 45° mydriatic digital photography used as a diabetic screening standard.

Conclusions:

The ungradable image rate of 3.3% for Clarus without mydriasis in a predominantly White Caucasian population was lower than reports for digital cameras.

The Zeiss Clarus 700 performed accurately in detecting any level of diabetic retinopathy using staged mydriasis with a sensitivity of 94.2% (95% CI 92.9% - 95.3%) and specificity of 87.3% (95% CI 85.4% - 89.0%) compared to the reference standard of two 45° mydriatic digital photography used in the English NHS DESP.

There was a steep learning curve for the grading team with some novel presentations of acquisition artefacts and colour differences in DR features.

Funding:

This study was supported by Innovate UK Grant, NIHR support funds to Gloucestershire Hospitals and an unrestricted research grant from CenterVue SpA.