

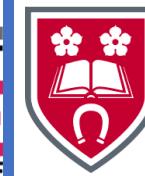
Feasibility and clinical utility of handheld fundus cameras for retinal imaging

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Introduction

Retinal imaging using fundus photography is an important step for objectively documenting and diagnosing retinal disorders. Fundus cameras have evolved significantly in the modern era with novel advancements in technology. Handheld smartphone-enabled (HSE) fundus cameras further progresses the utility of fundus imaging and increases its accessibility and ease-of-use among healthcare professionals (Panwar *et al*, 2016). To date there have been no studies comparing the clinical utility and quality of imaging using different HSE devices.

Aims

- Determining the success of image acquisition.
- Investigating the clinical gradeability of images acquired.
- Ranking image quality between different HSE fundus cameras.
- Assessing experience and preference from the participant point of view.

Methods

Five fundus cameras are compared for their clinical utility (Figure 1). Four of these cameras are HSE cameras and one of the cameras (Zeiss) is a tabletop fundus camera, serving as a baseline for comparison.

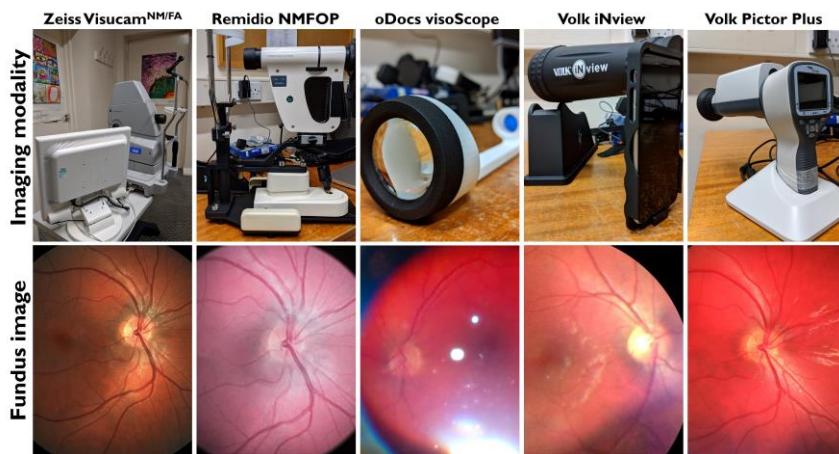


Figure 1: Comparison of the imaging modalities used in the study and their respective image outputs.

The study is composed of two stages:

- **Stage 1** – participants (n=10, mean age ± SD: 21.0±0.9 years), without any ophthalmic pathology underwent imaging with the devices and feedback on their experience was recorded.
- **Stage 2** – participants (n=8, mean age ± SD: 26.8 ±15.9) with optic disc swelling were imaged with the devices.

Clinicians (n=10) validated all the images as part of an expert panel and had a mean experience in ophthalmology of 15 years. The data was randomised and the clinicians were blinded.

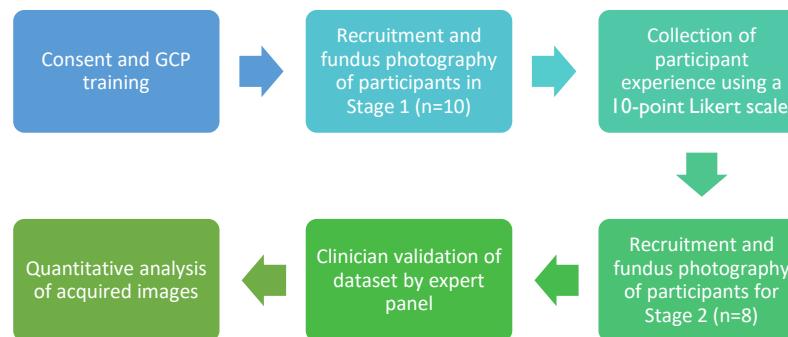


Figure 2: Flow chart visualising the methodology of the study.

Results

All images were successfully acquired in dilated and undilated settings for Zeiss, Remidio and Pictor (Figure 3A), whilst lower rates of success were observed with oDocs and iNview.

Clinical gradeability was highest using Remidio (Figure 3B) with 91% of images. Lowest scores of clinical gradeability was with oDocs.

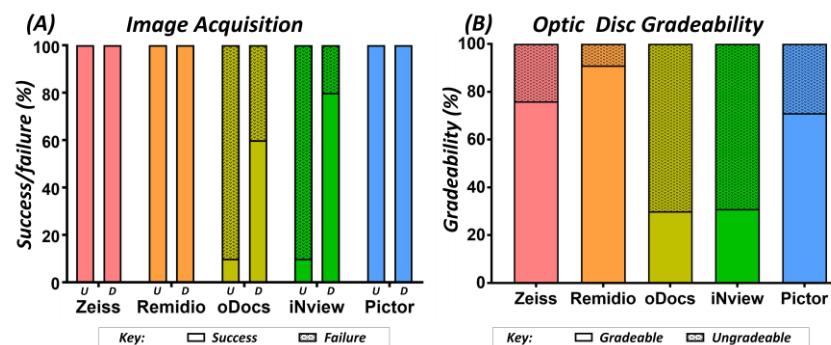


Figure 3: (A) Compound bar chart demonstrating the success/failure rates of image acquisition for participants involved in Stage 1 of the study in dilated (D) and undilated (U) settings. (B) Compound bar chart demonstrating the gradeability of images from Stage 2 of the study as validated by clinicians.

Zeiss and Remidio had the highest image quality rank (Figure 4) as graded by the clinicians (median=4, IQR=2). Zeiss, Remidio and Pictor had significantly higher image quality rank than oDocs and iNview ($p<0.001$).

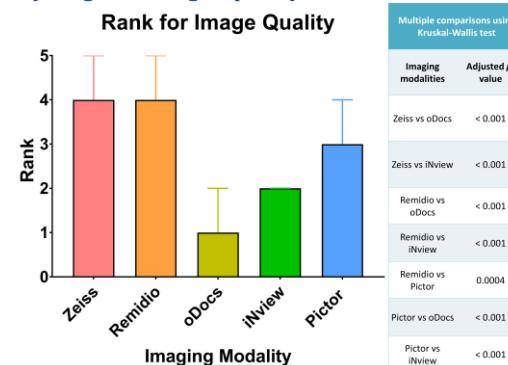


Figure 4: Bar chart demonstrating the median rank for image quality as validated by clinicians. Higher ranks indicate better image quality. The error bars display the upper interquartile value.

Imaging using Remidio was associated with the highest median comfort score (Figure 5) and was statistically significant when compared with iNview and oDocs (median=9, IQR=2, $p<0.02$). oDocs and iNview were associated with consistently lower rates of comfort.

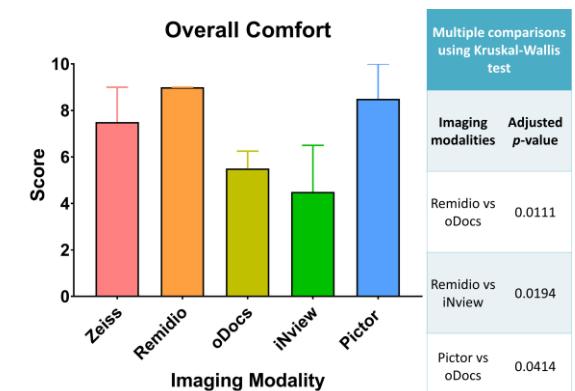


Figure 5: Bar chart demonstrating the median scores for overall comfort as given by participants in Stage 1 of the study. The error bars display the upper interquartile value.

Conclusions

This is the first study demonstrating a comparison of four different HSE devices and a table mounted fundus camera. Amongst the HSE devices, Remidio consistently achieved the highest scores in image acquisition, gradeability, image quality and overall comfort. Whilst the lowest scores were achieved by iNview and oDocs. As anticipated, oDocs and iNview were predominantly more successful at image acquisition in a dilated setting. Remidio and Pictor had comparable performance to the table-mounted Zeiss camera.

Clinical impact

These results suggest that Remidio can be used as an alternative imaging modality in situations where patients may not be able to attend an eye clinic (for example in bed-bound patients, rural settings, home visits) and communities in low-income countries. Imaging modalities used in this study ranged from £260 to £14,500 in price. This data therefore also provides valuable information on cost effective alternatives for clinical service planning.

Future implications

We anticipate that a future project may introduce a trial of HSE devices to paediatric populations who are often deprived of table mounted fundus imaging examinations due to poor cooperation and feasibility.

References

Panwar, N., et al. (2016) 'Fundus Photography in the 21st Century—A Review of Recent Technological Advances and Their Implications for Worldwide Healthcare', *Telemedicine Journal and e-Health*, 22(3), pp. 198.