A comparison of objective bulbar redness grading from images obtained using a slit lamp digital camera and an advanced corneal topographer

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Introduction

In clinical and contact lens practice it is important to record as accurately as possible the bulbar redness (BR) observed in patients[1]. To support ECPs numeric grading scales standardized are available to improve the record keeping[2-4]. The use different scales with photos or pictures and the subjective interpretation of results can lead to different results and low accuracy[5-7]. Recently a platform using computer vision is available to analyze digital images of the anterior segment and objectively grade the results for BR demonstrating an excellent repeatability and being more reliable than the standardized numeric grading scales[8,9]. The study aimed to evaluate the objective grading of BR of images obtained using a digital slit lamp and a corneal topographer including a digital color camera.

Methods

For this study were included 100 eyes to acquire images of nasal bulbar area using two different instruments, a slit lamp (700GL, Takagi) with a 12Mp digital camera and a corneal topographer including a digital color camera (Meridia Pro, Medmont International Pty,Ltd). Using both instruments three images of the same eye were acquired and uploaded to the AOS® Anterior (AOS Ltd.) platform designed to analyze the images of ocular anterior surface. After a manual selection of the region of interest (ROI), avoiding areas that could induce possible artefacts, the software automatically traced the vasculature and measured the bulbar redness (BR) using a scale ranging from 0-4 in 0.1unit steps and the percent vessel score (VS) indicating the percent of redness in the image (Fig. 1). For the statistical analysis, the average of the results obtained from the three different images were used. All statistical analyses were performed using MedCalc version 20 (MedCalc Software Ltd) using a paired sample t-test, considering a $P<0.05$ statistically significant, and the Bland–Altman plots to compare and to assess the agreement between the results obtained using the images from the two instruments.

Results

BR was significantly less ($P < 0.0001$) for images from slit lamp than for images from Meridia Pro with respectively a grade 1.14±0.79 (mean± SD) (95% CI for the mean 0.98 to 1.30) vs 2.11±0.80 (95% CI for the mean 1.94 to 2.26). Similarly, the VS was significantly less ($P < 0.0001$) for images from slit lamp than for the images from Meridia Pro with respectively a score of 23.21±7.45% (95% CI for the mean 21.71 to 23.21) vs 27.63±7.22% (95% CI for the mean 26.18 to 29.08) (Fig2). Bland-Altman plots show poor agreement between the two set of images analyzed with a bias of 0.96 and a 95% limits of agreement (LoA) from 1.75 to 0.17 for BR and a bias of 4.4 and a 95% LoA from 8.7 to 0.1 for VS (Fig 3).

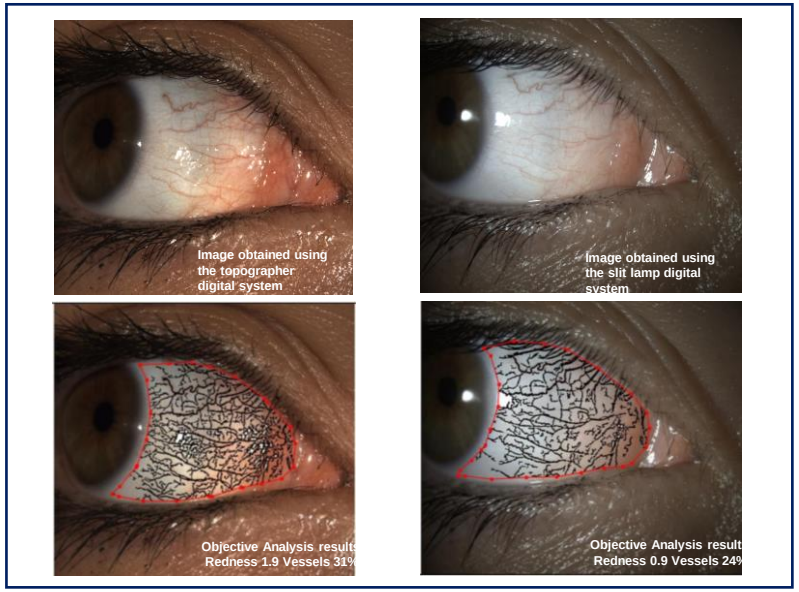

Figure 1. Objective grading of images from advanced topographer and slit lamp of the same eye

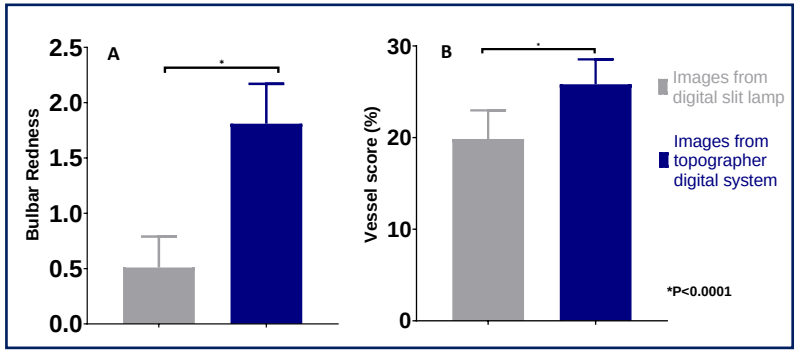

Figure 2. Bulbar redness (A) and vessel score (B) obtained from the two set of images analyzed

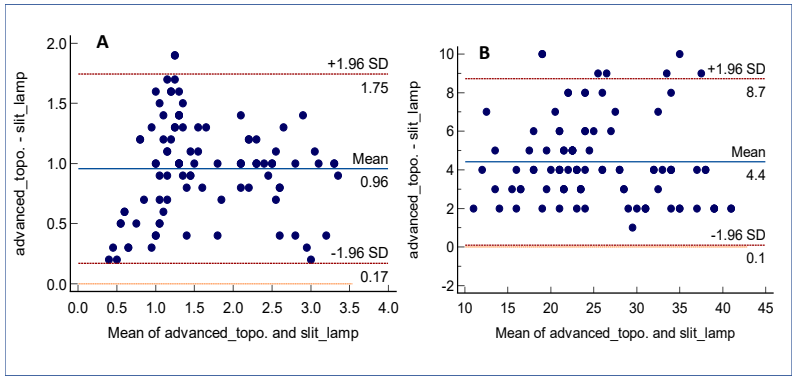

Figure 3. Bland and Altman plots comparing the results obtained from the two set of images analyzed for bulbar redness (A) and vessel score (B).

Conclusions

Objective analysis of ocular anterior segment images for bulbar redness with AOS® Anterior offers a high accurate and repeatable method compared with the subjective evaluation obtained using conventional grading scales as found in different studies[8,9]. Due to this high accuracy this analysis can be considered an excellent way to evaluate overtime changes of bulbar redness induced by ocular disease, ocular inflammation, dry eye or contact lens wear. To obtain reliable results the images analyzed must be obtained using always the same conditions to avoid grading errors. This condition can be easily obtained using an advanced corneal topographers where the magnification, the light source and the digital camera settings are fixed but not using a slit lamp with digital camera where these parameters can be modified. As evidenced by our results using different instruments the grading values are different. In fact, we found that the images obtained using the digital slit lamp tend to underestimate the bulbar redness and the vessel score compared to the images obtained using an advanced topographer making the two instruments not interchangeable. Further studies need to evaluate the effect of slit lamp settings on objective analysis of images with the aim to find the best configuration to use.

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References

1. Efron N. Contact lens complications 3th Ed. Elsevier 2012. p. 21
2. Efron N. Grading scales for contact lens complications. Ophthalmic Physiol Opt. 1998;18:182-186
3. Efron N., et al. Validation of grading scales for contact lens complications, Ophthalmic Physiol Opt. 2001; 21: 17–29
4. Terry R. et al. CCLRU standards for success of daily and extended wear contact lenses. Optom Vis Sci. 1993;70:234-43.
5. Marc M et al. The use of fractal analysis and photometry to estimate the accuracy of bulbar redness grading scales. Invest Ophthalmol Vis Sci. 2008; 49:1398-406.
6. Peterson R., Wolffsohn J., Sensitivity and reliability of objective image analysis compared to subjective grading of bulbar hyperaemia, Br J Ophthalmol. 2007; 91: 1464–1466.
7. Hwang J., et al. New clinical grading scales and objective measurement for conjunctival injection. Invest Ophthalmol Vis Sci. 2013; 54: 5249–5257
8. Huntjens B, et al. Evaluating a new objective grading software for conjunctival hyperaemia. Contact Lens Anterior Eye. 2020; 43:137–143
9. Walker M. A et al. comparison of subjective and objective conjunctival hyperaemia grading with AOS® Anterior software. Clin Exp Optom. 2022; 105:494-499.