Letter to the Editor

Quantitative Analysis of Optic Disc Color

Dear Editor,

I read with great interest the article by Kim et al. [1] regarding the use of ImageJ to quantitatively analyze the color of optic discs. The authors proposed three points to measure the intensity per pixel area after grayscale conversion, namely nasal rim (NR), brightest cupping center (BCC), and inferior retinal vein (IRV). They found good inter-observer correlation with this method, along with an age-related decrease of BCC pixel intensity.

However, the authors did not mention either the disc area or the characteristics of the subjects enrolled in the study. The optic disc area has a high inter-individual variability: large discs have a larger neuroretinal rim area, an increased total area of lamina cribrosa (LC) pores, and a higher ratio of interpore connective tissue area to total LC area [2]. Therefore, in large discs, it might be difficult to determine a representative region denoting BCC if significant pores of different color are located at the very center of the disc. In small discs, on the contrary, a minimal number of or no cups would make the measurement of BCC inaccurate or impossible. Both Varma et al. [3] and Kashiwagi et al. [4] pointed out there were no age-related differences in disc configuration 3,4. When the proportion of small : normal : large disc sizes in Kim's sample was not constant with age, there was a deviation of disc size in particular age group(s), indirectly reducing the accuracy of the correlation of BCC intensity with age.

Also, objective measurements of lens status, color, and opalescence were not performed other than a brief mention of best-corrected visual acuity greater than 20 / 25 in all subjects. In patients suffering from nucleosclerotic cataract, the visual acuity can be much preserved with a disproportionate loss of transparency. Media opacities are likely to be present to some extent in some of the older subjects, which is a major confounding factor. This should prompt the use of a more objective lens assessment system such as Lens Opacity Classification System III or Scheimpflug images to adjust the obtained parameters 5.

The ImageJ software enables a particular area of an image to be highlighted and a histogram of intensity to be calculated. Grewal et al. [5] employed this method to study different parts of a nuclear cataract and to determine cor-

relations among several visual functions 5. Its importance, in our context, is highlighted in analyzing optic neuropathies with sectoral pallor, such as ischemic optic neuropathy, 'bow-tie' atrophy from chiasmal compression, and pathological temporal pallor in nutritional optic neuropathy. The contrast of 'intensity' between different areas of a disc might be enhanced in borderline cases, which helps with diagnosis. Serial measurements can serve as a tool to longitudinally monitor patients. Alternatively, the whole neuroretinal rim or cup can be highlighted to provide a more generalized quantitative analysis of the region of interest.

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References

1. Kim US, Kim SJ, Baek SH, et al. Quantitative analysis of optic disc color. *Korean J Ophthalmol* 2011;25:174-7.
2. Jonas JB, Budde WM, Panda-Jonas S. Ophthalmoscopic evaluation of the optic nerve head. *Surv Ophthalmol* 1999;43:293-320.
3. Varma R, Tielsch JM, Quigley HA, et al. Race-, age-, gender-, and refractive error-related differences in the normal optic disc. *Arch Ophthalmol* 1994;112:1068-76.
4. Kashiwagi K, Tamura M, Abe K, et al. The influence of age, gender, refractive error, and optic disc size on the optic disc configuration in Japanese normal eyes. *Acta Ophthalmol Scand* 2000;78:200-3.
5. Grewal DS, Brar GS, Grewal SP. Correlation of nuclear cataract lens density using Scheimpflug images with Lens Opacities Classification System III and visual function. *Ophthalmology* 2009;116:1436-43.

Author Reply

Dear Editor,

Thank you for your consideration of our article. My main interest is in the change of disc pallor; however, there are few available objective tools or methods. Therefore, I want to study these objective tools to evaluate disc color change. As you know, there are many morphologic figures in the optic disc. Some optic discs have no cupping, and some have large cupping. In addition, it is difficult to

evaluate the brightest cupping center in a crowded disc. The focus of our study is reproducibility because there are many problems in evaluating disc color, as mentioned above. Three observers took part in the study and evaluated the disc in the same situation. As a result, the p -value of the largest inferior retinal vein was shown to be more significant than the other two components. This may result from a difficulty in locating the brightest cupping center, as you mentioned. However, we believe that the evaluation of optic disc color by ImageJ is worth considering. As you

mentioned, further evaluation using the whole neuroretinal rim or cup and serial follow-up study is needed. If you have any questions, please feel free to contact me (e-mail: ungsookim@kimeye.com).

Thank you.

Sincerely,

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