Published in final edited form as:

Br J Ophthalmol. 2009 November ; 93(11): 1552–1553. doi:10.1136/bjo.2008.144618.

Intraobserver variability of Confocal Scanning Laser Ophthalmoscopy with and without Stereo photographs

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Keywords

Glaucoma; confocal scanning laser ophthalmoscopy; screening; stereo photographs; intraobserver variability

INTRODUCTION

The purpose of this study is to determine whether optic disc photographs decrease the intraobserver variability of CSLO topographic parameters using the HRT II (Heidelberg Instruments-version 2.01).

METHODS

All participants lived near Madurai, India^{1,2}. A single operator used the HRT II and corrected for astigmatism and entered keratometry values.³ A trained photographer used a sequential stereo fundus camera (Kowa, Genesis D Standard) to take optic disc photographs.

We created 3 duplicate sets of topographic images. The observer (KP) used the stereo photographs to draw contour lines for the first set of images (C1). To eliminate bias from the previous contour line placement, he waited 2 months then randomly ordered the images, and randomly selected whether to place the contour line with (C2) or without (S) stereophotographs. After 2 months, he processed the third set of images (either C2 or S). Therefore, two separate topographies were created with photos (C1 and C2) and one created without photos (S).

The observer drew the contour line at Elschning's ring. As needed, he used interactive z-axis topographic display and 3-dimensional image to verify the position. When using stereo

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Competing Interests: None

Patient Consent: Obtained

Ethics Committee Approval: The Institutional Review Boards at Aravind Eye Hospital (Madurai, India) and Legacy Health System, Portland, OR approved the study. All of the investigations complied with the guidelines of the Declaration of Helsinki.

photographs (C1 and C2), he used a similar procedure but included stereophotographs, a stereo viewer, and a lighted viewing box.

For each topographic parameter, the absolute within-subject differences between S and C1 were calculated, $|S-C1|$. This was repeated for the other pairs of groups: $|S-C2|$ and $|C1-C2|$. We scaled these differences using the mean value to create a percent of variability (V) i.e. $V(S,C1) = \text{mean}(|S-C1|)/\text{mean}(C1) * 100\%$ for each subject. We used the Wilcoxon Signed Rank Test to compare the variability of (C1, C2) to (S, C1) and (S, C2). We used (C1, C2) as the comparison group because it represents intraobserver variability using the gold standard- optic disc photos.

RESULTS

The 68 subjects (38 females, 30 males) ranged in age from 35 to 60 years (mean 40.4, SD $\pm$ 4.9) with best-corrected visual acuity $\geq 20/40$. We graded the photographic stereopsis and image clarity as excellent (84%) or adequate (16%) in all photographs. The mean difference in topography parameters between groups is depicted in Table 1 and was not statistically significant. Table 2 shows the percentage of variability scaled by the mean value. Agreement between the groups in Moorfields classification ranged from 88–99% (data not shown).

DISCUSSION

These results show that stereo photographs do not decrease the intraindividual variability of CSLO parameters. Overall, these results suggest that an operator may not require stereo photographs to draw contour lines with CSLO.

The difference between contour lines drawn with disc photos $|C1-C2|$ was the gold standard. If photographs decreased variability, one would expect that variability for $|S-C1|$ to be greater than that of $|C1-C2|$. Interestingly, $|S-C1|$ showed a higher percentage of variability when compared to the gold standard group $|C1-C2|$ in 13 of the 20 parameters. A similar result occurred for $|S-C2|$.

Our study did not use the HRT III, the most recent CSLO software version. However, as in the HRT II, the HRT III version still requires placement of the contour line for topographic analysis, to perform the Moorfields Classification, and to compare progressive changes in topographic parameters over time.

It is possible that operators may have difficulty drawing contour lines and require optic disc photographs in eyes that are unusual such as those with tilted, myopic discs and circumferential zones of peripapillary atrophy. Perhaps higher resolution digital photography may have decreased the variability between the photography groups (C1 and C2). Finally, our results may not be applicable to an untrained or inexperienced operator, or when several different operators draw contour lines^{4,5,6}

Acknowledgments

Support: 5K23EY015501-1 (SLM), Good Samaritan Foundation, Heidelberg Engineering (equipment), Proctor Foundation

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Table 1

Comparison of absolute difference in topographic measures. |C1-C2| is the absolute difference between photos #1 (C1) and photos #2(C2); |S-C1| is the absolute difference between without photos (S) and with photos #1 (C1); and |S-C2| is the absolute difference between without photos (S) and with photos #2 (C2). |C1-C2| is the gold standard comparison group.

Parameter [†]	Mean of C1-C2 (SD)	Mean of S-C1 (SD)	Mean of S-C2 (SD)	P value [*]	P value ^{**}
da	.190 (.197)	.199 (.149)	.179 (.164)	0.39	0.76
cupar	.073 (.083)	.080 (.122)	.083 (.113)	0.87	0.64
ra	.178 (.163)	.181 (.125)	.172 (.154)	0.87	0.77
cd	.030 (.034)	.32 (0.37)	.032 (.046)	0.97	0.88
rd	.030 (.034)	.032 (0.37)	.032 (.046)	0.97	0.88
cv	.030 (.034)	.032 (0.32)	.032 (.046)	0.97	0.88
rv	.097 (.193)	.088 (.079)	.102 (.210)	0.61	0.69
mcd	.009 (.012)	.008 (.008)	.009 (.010)	0.98	0.40
mxcd	.015 (.016)	.016 (.016)	.016 (.011)	0.63	0.55
hvc	.056 (.132)	.043 (.046)	.054 (.140)	0.98	0.59
cupsh	.023 (.025)	.021 (.020)	.024 (.021)	0.56	0.36
rnfl	.038 (.077)	.031 (.036)	.038 (.084)	0.61	0.87
rnflxc	.203 (.384)	.175 (.185)	.207 (.413)	0.92	0.61
hcd	.075 (.094)	.068 (.078)	.061 (.085)	0.22	0.30
vcd	.067 (.103)	.059 (.089)	.064 (.095)	0.77	0.87
mxene	.023 (.026)	.019 (.022)	.021 (.024)	0.61	0.26
mxend	.046 (.115)	.036 (.043)	.047 (.128)	0.99	0.88
clmts	.034 (.040)	.034 (.032)	.032 (.040)	0.89	0.94
cmulti	.039 (.036)	.034 (.034)	.038 (.039)	0.50	0.92
avgvar	.001 (.002)	.001 (.003)	.002 (.003)	0.37	0.89

^{*} p value comparing |S-C1| and |C1-C2|

^{**} p value comparing |S-C2| and |C1-C2|

[†] da (disc area), cupar (cup area), ra (rim area), cd (cup/disc area ratio), rd (rim/disc area ratio), cv (cup volume), mcd (mean cup depth), mxcd (maximum cup depth), hvc (height variation contour), cupsh (cup shape), rnfl (mean RNFL thickness), rnflxc (RNFL cross-section area), hcd (horizontal cup/disc), vcd (vertical cup/disc), mxene (maximum contour elevation), mxend (maximum contour depression), CLMTs (Contour Line Modulation Temporal-Superior), CLMTi (Contour Line Modulation Temporal-Inferior), avgvar (average variability)

Table 2

Highest to lowest percent variability (Mean absolute difference divided by the mean value with photographs (C1)) of confocal scanning laser parameters.

Parameter *	Percent Variability C1-C2	Percent Variability S-C1
Mxcne	54.0	45.6
vcd	19.9	17.3
rv	18.3	16.9
CLMti	18.1	15.5
hcd	16.2	14.8
CLMts	16.2	15.0
cv	15.2	18.0
rnfl	13.7	11.2
nflxc	13.4	11.7
cupar	13.2	14.3
cd	13.1	13.8
hvc	12.8	10.0
mxend	11.6	9.2
cupsh	11.5	10.9
ra	9.9	10.2
da	8.1	8.5
mcd	4.3	3.7
rd	3.9	4.1
avgvar	3.3	3.1
mxcd	2.5	2.7

* mxcne (maximum contour elevation), vcd (vertical cup disc), rv (rim volume), CLMti (Contour Line Modulation Temporal-Inferior), hcd (horizontal cup/disc), CLMts (Contour Line Modulation Temporal-Superior), cv (cup volume), rnfl (mean RNFL thickness), nflxc (RNFL cross-section area), cupar (cup area), cd (cup/disc area ratio), hvc (height variation contour), mxend (maximum contour depression), cupsh (cup shape), ra (rim area), da (disc area), mcd (mean cup depth), rd (rim/disc area ratio), avgvar (average variability), mxcd (maximum cup depth)