Evaluation of OCT Summary Measures for Detection of Glaucoma Progression

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Purpose

To evaluate the performance of conventional and novel OCT summary measures on detecting progression of glaucomatous damage

Methods

HE Database

The total number of 3.5mm circle scans is 1803. There were also 1818 Posterior pole scans and 1859 BMO scans (i.e. sets of 24 radial scans).

There are 385 eyes from 198 patients with an average of 4.68311688311688 (±3.9670978384381 SD) 3.5mm circle scans (min: 1; max: 21)

For the posterior pole scans: 353 eyes from 198 patients with an average of 5.15014164305949 (±4.31535396108195 SD) volume scans (min: 1; max: 28)

For the BMO scans: 403 eyes from 206 patients with an average of 4.61290322580645 (±3.93593373751818 SD) sets of radial scans (min: 1; max: 21)

Circumpapillary RNFL

The following summary measures were calculated from every circle scan:

- Summary Measures
  - Global (G)
  - Temporal (T)
  - Temporal-Inferior (TI)
  - Temporal-Superior (TS)
  - Nasal-Inferior (NI)
  - Nasal-Superior (NS)
  - Nasal (N)

Note that the sectoral measures are based on Garway-Heath sectors.

Variability (short-term) Group

For a variability group, we collected all circle scans acquired within 4 months (+2 weeks); i.e. the short-term scans. The total number of repeat scans was 378. There were 161 eyes with short-term scans from 135 patients. Note the misalignment between number of eyes and number of patients. Since presence or absence of disease is not a factor for this group, MAPS non-study eyes were also included.

Mean age 55.3807407 (±19.6227309); Median age 61.1 (IQR: 37.5). Mean number of tests: 3.3478261 (±0.8892474); Median 4 (IQR: 2).

Progression (long-term) Study Group

For a progression study group, eyes with the most recent scan at least 11 months apart from the baseline test were included.

Eyes with at least 2 scans (1 baseline, 1 follow-up) were eligible for an event-based analysis.

Table 1: Characteristics of the Study Group, eligible for Event Analysis

Number of Study Eyes	Mean Age	St.Dev. Age	Median Age	IQR Age	Average Number of Tests	St. Dev. Tests	Median Number of Tests	IQR Tests
122	61.96066	17.14475	66.4	16.90833	6.639344	2.641267	7	4

Eyes with 4 or more scans were eligible for a trend-based analysis.

Table 2: Characteristics of the Study Group, eligible for Trend Analysis

Number of Study Eyes	Mean Age	St.Dev. Age	Median Age	IQR Age	Average Number of Tests	St. Dev. Tests	Median Number of Tests	IQR Tests
105	60.33524	17.73091	65.5	17.73333	7.304762	2.206301	7	3

Variability (Short-Term) Measures

Quantile Regression was used to derive thresholds of significant progression. Unlike regular linear regression (Least Squares), which calculates the conditional mean of the target across different values of the features, quantile regression estimates the conditional median (and other percentiles) of the target. This means that instead of being constants, the beta coefficients are now functions with a dependency on the quantile.

The table below provides those beta coefficients for the extreme 5 and 2.5 percentiles on both sides of the distribution (i.e. significant progression and significant improvement).

Progression based on Event Analysis

Table 3: Results of Event-Based Analysis for cRNFL metrics

Summary Metric	Study Group	Total Number	Significant Progression at 2.5%	Significant Progression at 5%
G	HC	28	2	3
G	P	85	24	30
N	HC	28	2	3
N	P	85	10	29
NI	HC	28	0	2
NI	P	85	12	24
NS	HC	28	2	5
NS	P	85	14	21
T	HC	28	1	4
T	P	85	15	21
TI	HC	28	1	2
TI	P	85	14	26
TS	HC	28	1	3
TS	P	85	17	27

Progression based on Trend Analysis

Table 4: Results of Trend-Based Analysis for cRNFL metrics

Summary Metric	Study Group	Total Number	Significant Progression at 2.5%	Significant Progression at 5%
G	HC	27	5	6
G	P	72	24	27
N	HC	27	6	7
N	P	72	12	19
NI	HC	27	4	5
NI	P	72	21	26
NS	HC	27	4	6
NS	P	72	21	25
T	HC	27	4	4
T	P	72	13	15
TI	HC	27	4	5
TI	P	72	17	23
TS	HC	27	1	3
TS	P	72	13	20

Table 5: Mean Slope per Group per Metric

Study Group	Summary Metric	Mean Slope
G	HC	-0.4527311
G	P	-0.7348051
N	HC	-0.5764478
N	P	-0.2704823
NI	HC	-0.4078135
NI	P	-1.3384401
NS	HC	-0.8448791

Study Group	Summary Metric	Mean Slope
NS	P	-1.3928098
T	HC	-0.3141352
T	P	-0.3244114
TI	HC	-0.0114213
TI	P	-1.3767285
TS	HC	-0.5236468
TS	P	-1.0255303

Table 6: Results of Trend-Based Analysis for cRNFL metrics, accounting for age-effect

Summary Metric	Study Group	Total Number	Significant Progression at 2.5%	Significant Progression at 5%
G	HC	29	5	6
G	P	75	23	27
N	HC	29	6	7
N	P	75	12	19
NI	HC	29	4	5
NI	P	75	22	27
NS	HC	29	4	6
NS	P	75	21	24
T	HC	29	4	4
T	P	75	13	15
TI	HC	29	4	5
TI	P	75	19	25
TS	HC	29	1	3
TS	P	75	14	20

Variability (short-term) Group - Macular Metrics

For a variability group, we collected all posterior pole scans acquired within 4 months (+2 weeks); i.e. the short-term scans. The total number of repeat scans was 388. There were 171 eyes with short-term scans from 138 patients. Note the misalignment between number of eyes and number of patients. Since presence or absence of disease is not a factor for this group, MAPS non-study eyes were also included.

Mean age 55.85 (±19.6711699); Median age 61.35 (IQR: 36.625). Mean number of tests: 3.2690058 (±0.912739); Median 4 (IQR: 2).

Table 7: Results of Event-Based Analysis for Macular metrics

Summary Metric	Study Group	Total Number	Significant Progression at 2.5%	Significant Progression at 5%
G_8degrees	HC	28	2	2
G_8degrees	P	85	29	35
I_8degrees	HC	28	0	4
I_8degrees	P	85	26	35
S_8degrees	HC	28	0	1
S_8degrees	P	85	18	23

Table 8: Results of Trend-Based Analysis for Mac metrics

Summary Metric	Study Group	Total Number	Significant Progression at 2.5%	Significant Progression at 5%
G_8degrees	HC	27	5	7
G_8degrees	P	72	19	24
I_8degrees	HC	27	4	8
I_8degrees	P	72	19	23
S_8degrees	HC	27	5	7
S_8degrees	P	72	16	17

Table 9: Mean Slope per Group per Mac Metric

Study Group	Summary Metric	Mean Slope
G_8degrees	HC	-0.2182008
G_8degrees	P	-0.4012580
I_8degrees	HC	-0.2515862
I_8degrees	P	-0.4438990
S_8degrees	HC	-0.1895429
S_8degrees	P	-0.3644707

Table 10: Results of Trend-Based Analysis for Mac metrics, accounting for age-effect

Summary Metric	Study Group	Total Number	Significant Progression at 2.5%	Significant Progression at 5%
G_8degrees	HC	27	5	7
G_8degrees	P	77	19	23
I_8degrees	HC	27	4	8
I_8degrees	P	77	20	23
S_8degrees	HC	27	5	7
S_8degrees	P	77	16	17

Structure-Structure Comparison

Table 11: Results of Event-Based Analysis for G and Gmac

Study Group	Total Number	Significant Progression at 2.5% G AND Gmac	Significant Progression at 5% G AND Gmac	Significant Progression at 2.5% G OR Gmac	Significant Progression at 5% G OR Gmac
HC	28	0	0	4	5
P	85	16	20	37	45

Table 12: Results of Trend-Based Analysis for G and Gmac

Study Group	Total Number	Significant Progression at 2.5% G AND Gmac	Significant Progression at 5% G AND Gmac	Significant Progression at 2.5% G OR Gmac	Significant Progression at 5% G OR Gmac
HC	27	1	1	9	12
P	72	12	14	31	37

Table 13: Results of Event-Based Analysis for S and I sectors (hemifields)

Study Group	Total Number	Significant Progression at 2.5% TI OR TS OR Imac OR Smac	Significant Progression at 5% G TI OR TS OR Imac OR Smac	Significant Progression at 2.5% (TI OR TS) AND (Imac OR Smac)	Significant Progression at 5% (TI OR TS) AND (Imac OR Smac)	Significant Progression at 2.5% (TI AND Imac) OR (TS AND Smac)	Significant Progression at 5% (TI AND Imac) OR (TS AND Smac)
HC	28	2	10	0	0	0	0
P	85	39	53	16	23	14	21

Table 14: Results of Trend-Based Analysis for S and I sectors (hemifields)

Study Group	Total Number	Significant Progression at 2.5% TI OR TS OR Imac OR Smac	Significant Progression at 5% G TI OR TS OR Imac OR Smac	Significant Progression at 2.5% (TI OR TS) AND (Imac OR Smac)	Significant Progression at 5% (TI OR TS) AND (Imac OR Smac)	Significant Progression at 2.5% (TI AND Imac) OR (TS AND Smac)	Significant Progression at 5% (TI AND Imac) OR (TS AND Smac)
HC	27	11	16	1	2	0	2
P	72	37	46	10	15	9	14