

## Inter-observer agreement and sensitivity of Optomap images for screening peripheral retinal lesions in patients undergoing refractive surgery

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**Purpose:** The aim of this study was to compute the sensitivity, specificity and inter-reader variability of ultra-widefield retinal imaging (Optomap 200Tx) for screening retinal lesions before myopic refractive surgery. **Methods:** Two hundred and eight eyes of 109 consecutive refractive surgery candidates were included in this study. All subjects underwent Optomap 200Tx, mydriatic slit-lamp lens examination and dilated retinal examination with scleral indentation by a retinal specialist. Retinal findings by indirect dilated examination by retinal specialist was considered as the gold-standard. Sensitivity analyses for the readers were calculated between the Optomap images and the gold-standard retinal examination. **Results:** Seventy-three of the 208 eyes (35.1%) had peripheral retinal lesions diagnosed by the retinal specialist on dilated fundus examination. Peripheral lesions were seen on the Optomap images in 111 (53.4%) eyes. Compared to the dilated retinal examination, the detection rate with the Optomap 200Tx was 78.1% and specificity rate was 60%. The accuracy rate between the 3 readers ranged from 72% to 87%. The highest accuracy was noted with the reader post 1 year of retinal training (86.54%). **Conclusion:** The Optomap 200Tx showed a high sensitivity and moderate specificity for identifying peripheral retinal lesions in eyes undergoing refractive surgery. The Optomap examination is a convenient, fast and feasible method for detecting the pathological fundus changes in myopic eyes. The reliability of the examination improves when the images are interpreted by a reader with prior retinal training.

**Key words:** Optomap Daytona 200Tx, refractive surgery, ultrawide field imaging

Myopia is the most common type of refractive error seen in day-to-day clinical practice.<sup>[1]</sup> Higher the grade of myopia, more is the prevalence of peripheral retinal degenerations.<sup>[2-5]</sup> A rhegmatogenous retinal detachment (RRD) can occur in eyes with peripheral retinal degenerations like lattice degeneration, snail-track degeneration, retinal tears/holes, degenerative retinoschisis, cystic retinal tufts, and, rarely, zonular traction tufts.<sup>[6]</sup> With improving technology and better outcomes over the past few decades, we have seen an increase in surgical correction of refractive errors, particularly myopia.

The common refractive procedures used in the correction of myopia include surface ablation techniques like photorefractive keratotomy, laser in-situ keratomileusis (LASIK) and femtosecond LASIK, intraocular surgeries like intrastromal corneal ring segments, phakic intraocular lens and elective refractive lens exchange and newer procedures like small incision lenticule extraction.<sup>[7-13]</sup> The occurrence or the progression of posterior vitreous detachment either due to pre-existing high myopia or following refractive surgery can lead to retinal tears and an RRD.<sup>[14-19]</sup> Thus, a dilated fundus examination of myopic eyes before undergoing refractive

surgery is mandatory to identify these predisposing lesions for appropriate treatment and follow up. While a dilated retinal examination with an indirect ophthalmoscope and indentation remains the gold standard to detect these lesions, alternate strategies of retinal screening are required in some instances. These include patients who do not consent for pupil dilatation, either due to allergy to dilating drops, post-dilatation blurring of vision or lack of time. Another instance is the recent Covid-19 pandemic wherein human-to-human interaction has to be kept to a bare minimum. Large refractive surgery practices without a trained retinal specialist is another such scenario. Widefield non-mydriatic or mydriatic retinal imaging does allow screening up to 200 degrees of the retina.

The Optos Optomap Daytona Panoramic 200Tx (Daytona, Optos®, UK) is one such device that can be used for retinal screening of peripheral degenerative lesions.<sup>[20-22]</sup> It is a confocal laser scanning ophthalmoscope designed to obtain wide-field images of the retina, more than 200° in one single image. This image can be obtained even without pharmacological mydriasis with an acquisition time of <0.4 seconds.<sup>[23]</sup> Hence, ultrawide

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field imaging is increasingly being used in teleophthalmology settings, especially for screening of diabetic retinopathy.<sup>[24,25]</sup> Although this device has been touted as a baseline retinal examination tool in a number of ocular pathologies like cataract, eye trauma, and diabetic retinopathy,<sup>[26-28]</sup> there is little evidence in the literature reporting its sensitivity and specificity for the identification of peripheral retinal lesions.<sup>[20-22]</sup> Also, there is a huge variation in the detection rate of peripheral lesions ranging from 57% to 74% on the non-dilated Optomap images.<sup>[20,21]</sup> Identification of lesions on Optomap images can vary between readers<sup>[20,22]</sup> and these variations can be used to identify readers with a minimum basic level of retinal training for maximum agreement with retinal examination findings.

In this context, we studied the sensitivity of Optomap ultrawide field imaging system as a screening tool for the detection of peripheral retinal degenerations. We compared the identification of retinal lesions using Optomap images with the gold standard dilated fundus examination with scleral indentation by a retinal specialist. To further characterize the Optomap, analysis was performed separately between retinal lesions which predispose to RRD requiring prophylactic laser treatment and lesions which do not predispose to RRD.

## Methods

This retrospective study was approved by the Institutional Review Board (C-2020-05-006) and was in accordance with the tenets outlined in the Declaration of Helsinki. One hundred and nine patients who were advised refractive surgery for myopia between January 2020 and March 2020 were screened in the retina clinic of a tertiary eye care hospital in South India. All patients underwent a comprehensive eye examination including slit-lamp biomicroscopy and dilated fundus examination with scleral indentation by a single retinal specialist (CJ). Retinal image acquisition was done by the Optos Daytona device (Daytona, Optos®, UK), which is a scanning laser ophthalmoscope with two scanning laser wavelengths of green (532 nm) and red (635 nm). The ultra-widefield Optomap images were captured by a skilled technician, who was masked to the results of the retinal evaluation. The images were acquired through dilated pupils immediately after dilated retinal examination by a retinal specialist in the auto-capture mode. Participants were seated in front of the Optos instrument and instructed to look through an aperture at a green central fixation target in the primary position. To fine-tune subject positioning and to provide stability, an adjustable air cushion around the aperture was in contact with subjects' orbital rim. Once the green fixation target became visible and focussed to the subjects, the machine automatically captures the image. Additional images of the retinal periphery were obtained after asking the subjects to look at the 3, 6, 9 and 12 o'clock positions (image steering technique). Thus, a total of 5 images were captured for each eye. The image could be immediately viewed by the examiner. Images were recaptured till the required quality was reached. In most subjects, both eyes were imaged.

The Optomap images with the least eyelash artifacts and largest retinal area captured were selected in a JPEG format of 3470 × 1498 pixels for analysis. Four ophthalmologists with different levels of training in retinal examination evaluated the images independently in a masked fashion. These included one retina consultant with 1-year experience

post-fellowship (Reader 1, RV), two retina fellows having 12-months (Reader 2, NR) and 6-months (Reader 3, JPC) experience and one postgraduate student having 3-months of training in retina (Reader 4, AADI). Their goal was to identify all peripheral retinal lesions. Readers were only required to detect lesions, and were instructed not to provide a diagnosis. In case an eye had multiple lesions, all the lesions were to be noted [Fig. 1]. The findings of the Reader 1 were used to calculate the sensitivity of the Optomap images to identify the peripheral lesions in comparison to the gold standard dilated retinal examination by a retinal specialist. In case of any confusion, a senior retinal specialist (NKY) re-evaluated the picture and his opinion was considered to be final. The accuracy between Readers 2, 3 and 4 were tested to check which reader can identify the peripheral lesions correctly.

## Statistical analysis

The analysis was done using the Microsoft Excel 2016. Continuous variables like age and spherical equivalents were described in the form of mean and standard deviation while categorical variables like sex and laterality were described as absolute numbers and percentages. In this study, sensitivity analyses (sensitivity, specificity, positive and negative predictive values and accuracy) were calculated comparing the findings between the Optomap images and the gold-standard retinal examination. Sensitivity for detection of retinal lesions using the Optomap was calculated in three categories. The first was the sensitivity for all lesions identified, regardless of whether they required treatment, termed as overall sensitivity. This was calculated as the total number of lesions identified on Optomap evaluation (numerator) divided by the total number of lesions identified by a retinal specialist during the gold standard examination with scleral indentation (denominator). The second calculation addressed the sensitivity of the Optomap images for detecting lesions that could predispose to an RRD. The third was the sensitivity for the individual lesions identified, which was termed as the lesion sensitivity. For example, the lesion sensitivity for lattice degeneration was calculated by the number of eyes with lattice degeneration identified on the Optomap images divided by the number of eyes with lattice degeneration identified by the retina specialist during retinal examination. Specificity was calculated to identify the true-negatives, which was the number of eyes either correctly identified as normal or which did not show that specific lesion on the Optomap evaluation divided by the number of eyes identified as normal or which did not have the lesion during the retinal examination. A value of  $P < 0.05$  was considered statistically significant.

## Results

### Patient characteristics

A total of 208 eyes of 109 patients (male, 52, 47.7%; female, 57, 52.3%) were included in the study. There were 102 right eyes and 106 left eyes in the study. The mean age of patients was  $29.0 \pm 10.5$  years (range: 20–49 years), while a majority of patients (78/109, 72.2%) were not more than 30 years. Spherical equivalent refraction of the eyes of the subjects averaged  $-5.15 \pm 3.23$ D.

### Presence of peripheral retinal lesions

On retinal examination, 73 of 208 (35.1%) eyes showed peripheral retinal lesions. More than one treatable peripheral lesion was noted in some eyes. Lattice degeneration was the



**Figure 1:** Pictures of typical peripheral retinal lesions seen on Optomap images: (a) Lattice degeneration; (b) Snail-track degeneration with retinal hole; (c) Snowflake degeneration; (d) Atrophic retinal hole; (e) Paving stone degeneration; (f) Retinoschisis; (g) White without pressure; (h) Congenital hypertrophy of retinal pigment epithelium

most common peripheral degeneration seen among 42 of the 73 (57.5%) eyes followed by retinal holes/tears identified in 17 (23.2%) eyes. Degenerations which could predispose to the development of retinal detachment were identified in 50 (68.5%) eyes. A total of 1040 Optomap images were scanned to identify the peripheral lesions in 208 eyes of 109 subjects. Peripheral lesions were seen on the Optomap images in 111 (53.4%) of the 208 eyes. The sensitivity and specificity of the Optomap images to identify the peripheral lesions compared to the gold-standard retinal examination by a retinal specialist was 78.1% and 60%, respectively. Peripheral lesions, which can predispose to RRD, was identified in 34 (68%) eyes, while lesions that may not predispose to RRD were identified in 139 (88%) eyes on the Optomap images [Table 1].

#### Accuracy amongst the readers for the identification of peripheral retinal lesions

In this study, the accuracy rate of Reader 2 (86.54%) was the highest on comparison to the accuracy rates of Readers 3 (79.33%) and 4 (72.03%) for the retinal lesions which predispose to RRD and require treatment. A similar agreement pattern was noted between the three readers and retinal examination for identifying lesions that did not predispose to the development of RRD [Table 2].

## Discussion

We assessed the sensitivity and specificity of the Optomap images for the detection of peripheral retinal lesions from a cohort of patients who underwent dilated retinal screening with scleral indentation by a retina specialist in this study. The detection rate of the Optomap images for identifying all types of peripheral retinal lesions was 78.1%. Our study had a higher detection rate for peripheral retinal degenerations when compared to a recent study by Yang *et al.*<sup>[20]</sup> In their study, the overall sensitivity for identifying peripheral lesions was 65.2%. The sensitivity rate of the Optomap for detecting retinal tears and holes was 76.5% in our study compared to 57.3% in a study by Yang *et al.*<sup>[20]</sup> The high detection rate in our study could be explained by the following reasons: 1) the image steering technique used for the acquisition of fundus images; 2) images were obtained with adequate pupillary dilatation and lid retraction to avoid artifacts from the eye

lashes; 3) image evaluation by a trained retina specialist. In a study by Mackenzie *et al.*,<sup>[22]</sup> the overall sensitivity of lesions located posterior to equator was 74% and 45% for lesions located anterior to equator. The low detection rate for lesions anterior to equator was mainly attributed to the decline in the image quality and resolution at the periphery.

The overall specificity of the Optomap images was 60% in our study. However, in other studies, the true negative rate of the Optomap images ranged from 85% to 99.58%.<sup>[20,22]</sup> The Optomap images used in our study included eyes with and without peripheral degenerations while in the study by Mackenzie *et al.*, only images of eyes diagnosed with peripheral retinal degenerations by a retinal specialist were included. The sensitivity and specificity of the Optomap in detecting peripheral lesions accurately in different settings varies based on the gold standard and recording of lesions in the medical records, which is in turn dependant on the skills and experience of clinicians. In our study, we found that the sensitivity and specificity of the Optomap images for lesions predisposing to RRD was 68% and 88.6%, respectively. The sensitivity and specificity for lesions not predisposing to RRD was 88% and 84%, respectively. A higher detection rate by the Optomap for lesions not predisposing to RRD could be explained by the fact that while screening the retinal periphery before refractive surgery the main focus is to identify only lesions that predispose to RRD. Thus, there is suboptimal documentation of the lesions not predisposing to RRD in the medical records.

In this study, we analyzed the results between readers with different levels of retinal training for identifying peripheral retinal lesions in comparison to retinal findings noted on the gold standard dilated retinal examination with scleral indentation by a retina specialist. Reader 2 having experience of 12-months in retinal training showed the highest accuracy rate (accuracy rate = 86.54%, sensitivity = 84% and specificity = 87.3%) with the findings on gold standard retinal examination for lesions predisposing to RRD. Thus, one could conclude that ophthalmologists having completed at least 1 year of retinal training should be able to identify the peripheral lesions on Optomap images with good reliability.

Limitations of our study included a small sample size and no longitudinal tracing of the peripheral lesions by Optomap

**Table 1: Sensitivity and specificity of the Optomap images to identify the peripheral retinal lesions in comparison to retinal examination by retinal specialist**

	Optomap images	Retinal examination		Sensitivity	95% CI	Specificity	95% CI	P
		P	A					
Peripheral lesion present	P	57	54	0.781	0.673 – 0.860	0.600	0.516 – 0.679	<0.001
	A	16	81					
Lesions predisposing to RRD	P	34	18	0.68	0.542-0.792	0.886	0.827 – 0.927	<0.001
	A	16	140					
Lesions not predisposing to RRD	P	139	8	0.88	0.820 – 0.922	0.840	0.715 – 0.917	<0.001
	A	19	42					
LD	P	16	11	0.381	0.350 – 0.532	0.934	0.885 – 0.963	<0.001
	A	26	155					
STD	P	0	23	-	-	0.889	0.840 – 0.925	>0.999
	A	0	185					
Holes/tears	P	13	17	0.765	0.527 – 0.904	0.911	0.862 – 0.944	<0.001
	A	4	174					
SFD	P	0	7	-	-	0.966	0.932 – 0.984	>0.999
	A	0	201					
PSD	P	2	5	1.00	0.178 – 1.00	0.976	0.944 - 0.990	0.001
	A	0	201					
WWOP	P	14	47	0.583	0.388 – 0.755	0.745	0.677 – 0.802	0.002
	A	10	137					
CHRPE	P	1	0	1.00	0.051 – 1.00	1.00	0.982 – 1.00	0.005
	A	0	207					
CRA	P	0	8	-	-	0.962	0.926 – 0.980	>0.999
	A	0	200					
Abnormal vitreoretinal adhesion	P	0	5	0.00	0.00 – 0.561	0.976	0.944 – 0.990	>0.999
	A	3	200					

P – Present; A – Absent; RRD – Rhegmatogenous retinal detachment; LD – Lattice degeneration; STD – Snail-track degeneration; SFD – Snow flake degeneration; PSD – Paving stone degeneration; WWOP – White without pressure; CHRPE – Congenital hypertrophy of the retinal pigment epithelium; CRA – Chorioretinal atrophy

**Table 2: Agreement between the reader and gold-standard retinal examination for identifying peripheral lesions which predispose to develop retinal detachment and those that do not predispose to develop retinal detachment**

	Optomap images	Reader	Retinal examination		Sensitivity	Specificity	PPV	NPV	Accuracy
			P	A					
Lesions which predispose to RRD	Reader 2	P	42	20	84.00%	87.34%	67.74%	94.52%	86.54%
		A	8	138					
	Reader 3	P	33	26	66.00%	83.54%	55.93%	88.59%	79.33%
		A	17	132					
	Reader 4	P	31	10	62.00%	93.67%	75.61%	88.62%	72.03%
		A	19	148					
Lesions which do not predispose to RRD	Reader 2	P	138	8	87.34%	84.00%	94.52%	67.74%	86.54%
		A	20	42					
	Reader 3	P	132	17	83.54%	66.00%	88.59%	55.93%	79.33%
		A	26	33					
	Reader 4	P	148	19	93.67%	62.00%	88.62%	75.61%	72.03%
		A	10	31					

P – Present; A – Absent; RRD – Rhegmatogenous retinal detachment; PPV – Positive predictive value; NPV – Negative predictive value

after refractive surgery. The Optomap has a few disadvantages of its own. When using the Optomap, the ellipsoid mirror and

the spherical nature of the globe result in distortion of the peripheral image and prevent visualization of the peripheral

retinal structures on the image. Also, 360° ora serrata cannot be captured in a single image. The major advantages of this study are the high number of good quality images acquired for each eye and image steering technique used for image acquisition, thereby allowing a higher percentage of peripheral lesions to be detected on Optomap.

## Conclusion

In conclusion, the Optos Optomap Daytona 200Tx showed a high sensitivity and moderate specificity for identifying peripheral retinal lesions in eyes undergoing refractive surgery. The Optomap 200Tx examination is a convenient and feasible method for fundus pathological changes detection in myopic eyes. The reliability of the examination improves when the images are interpreted by a reader having at least one year of retinal training. Considering the high sensitivity of Optomap to detect different peripheral lesions, its utilization in teleophthalmology would be the future ahead.

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## Conflicts of interest

There are no conflicts of interest.

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