Utility of dynamic aberrometry for acuity measurements and testing

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Purpose:

The purpose of this study is validating utility of dynamic aberrometry versus static aberrometry.

Fig. 1 Aberrometer Multispot 250

Methods:

We use an original aberrometer MULTISPOT-250 (MSU, Russia) for comparing data of subjective refraction and measured aberration. 200 patients, 18-50 years old, pre- and post- LASIK, with -9..+6D refraction were studied with the use of TOPCON KR8100 and MULTISPOT 250. *Mydriacyl* 1% was used for all measurements.

Specification and features:

MULTISPOT-250 aberrometer is a Shack-Hartmann sensor based real-time aberrometer.

The unique feature of the instrument is a scanning reference spot, which greatly improves accuracy (below wavelength/10) and speed (up to 70 Hz) of aberration measurements. The reference picture for the sensor contains up to 300 spots (for 8 mm pupil). The aberrations are presented as Zernike polynomial coefficients up to 6-th order.

One series of measurements can include up to 1000 samples (record time is 30s at 30Hz frame rate).

The device has detection of pupil size and position based on the Shack-Hartmann picture and eye image. (See Fig. 2). In the case of large displacement of these pupils the corresponding data are neglected.

Automatic compensators allow measurement of patients within large ranges of ametropia(-15..+15D) and cylinder (±6D).

Built-in controllable target projector permits carrying out dynamic accommodation measurements.

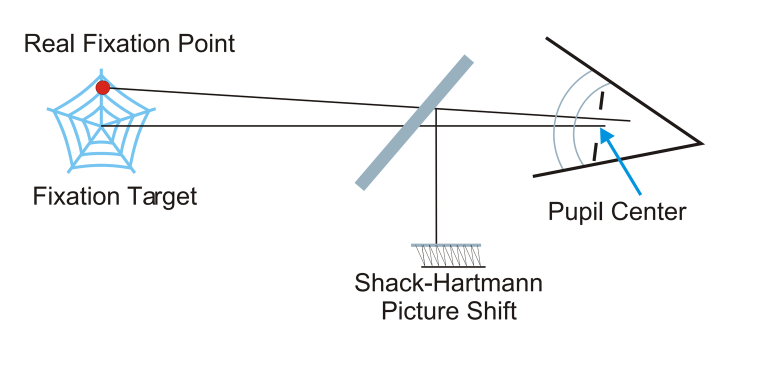

Fig. 2 Displacement of ShH pupil vs. Eye pupil

Results: Dynamic vs. static aberrometry:

A group of 200 patients (150 myopic and 50 hypermetropic) was under study. Measurements were done with the use of the auto refractometer TOPCON KR8100 and aberrometer MULTISPOT250. Static aberration measurements were obtained as single frames from dynamic series with 1-sec. rate. We then compared these measurements with clinical (manifested) refraction. Table 1. shows percent of measurements matching clinical data within 0.25D limit.

Instrument	Myopic	Hypermetropic	Total
TOPCON KR8100	93%	90%	92%
MULTISPOT250 (static data)	81%	70%	78%
MULTISPOT250 (dynamic data)	97.5%	93%	97%

Table 1. Comparing of measurements with the use of different instruments

Significant difference between static and dynamic data are caused by several factors: unstable eye position, tear films etc.

To separate invalid measurement frames we use an original algorithm, which include compare of pupil size and positions obtained from Hartmannogram and pupil image pictures. Figure 3.

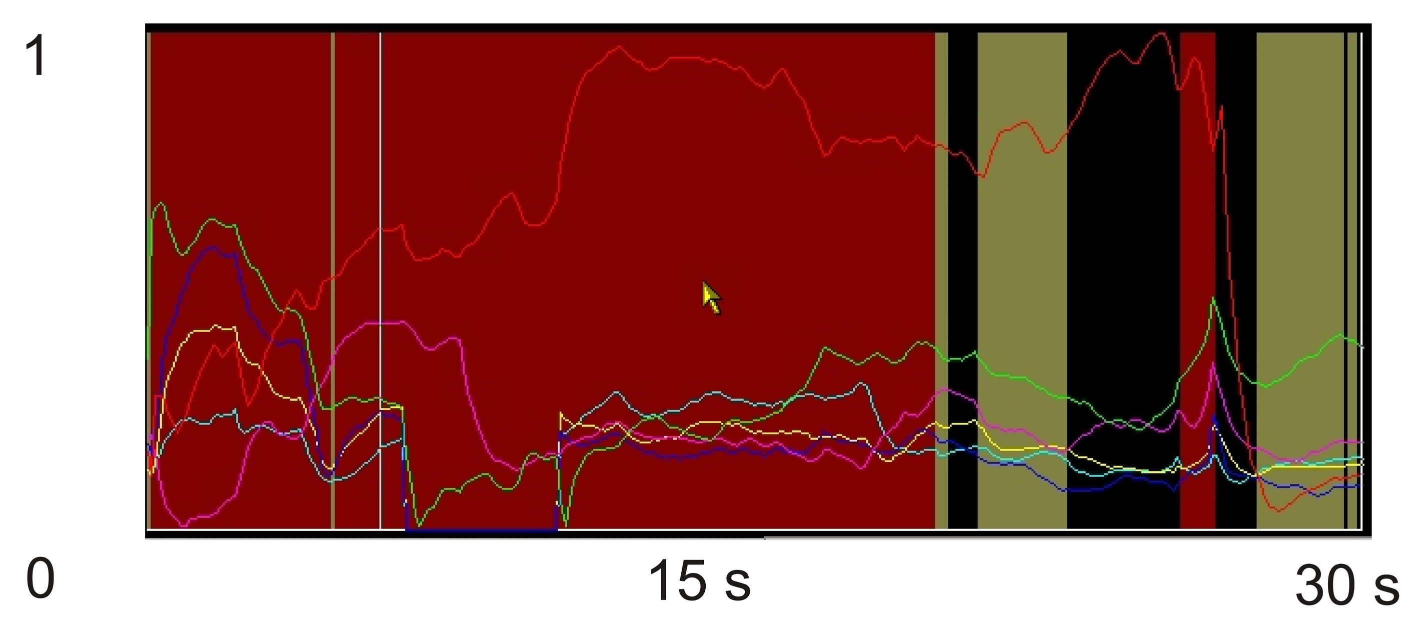

Fig.3 Zernike coeff. amplitudes (AU) vs. time.

illustrates the typical time plot of an aberration measurement.

Black zone indicates valid measurements; invalid measurements are marked with olive and dark red. Relative Standard Deviation (RSD) over the good zone is less than 1%; RSD over the total area is 17%. “Static” measurements (that is, taken with 1-s rate) show RSD larger than 20%. (Tilts, shown in red line, are ignored).

Rather poor results are shown for post-operated hypermetropic patients. This is caused by the irregularity of the wave sensor signal within the transition zone.

Data interpretation and usage:

Another problem under investigation was calculation of refraction from aberration data. We tested several approaches, including a popular Seidel method, minimum PSF radius method etc. We found that the minimum RMS sphere fit method is the closest to clinical measurements. In the case of patients with higher order aberrations our algorithm allowed us to control compensators automatically

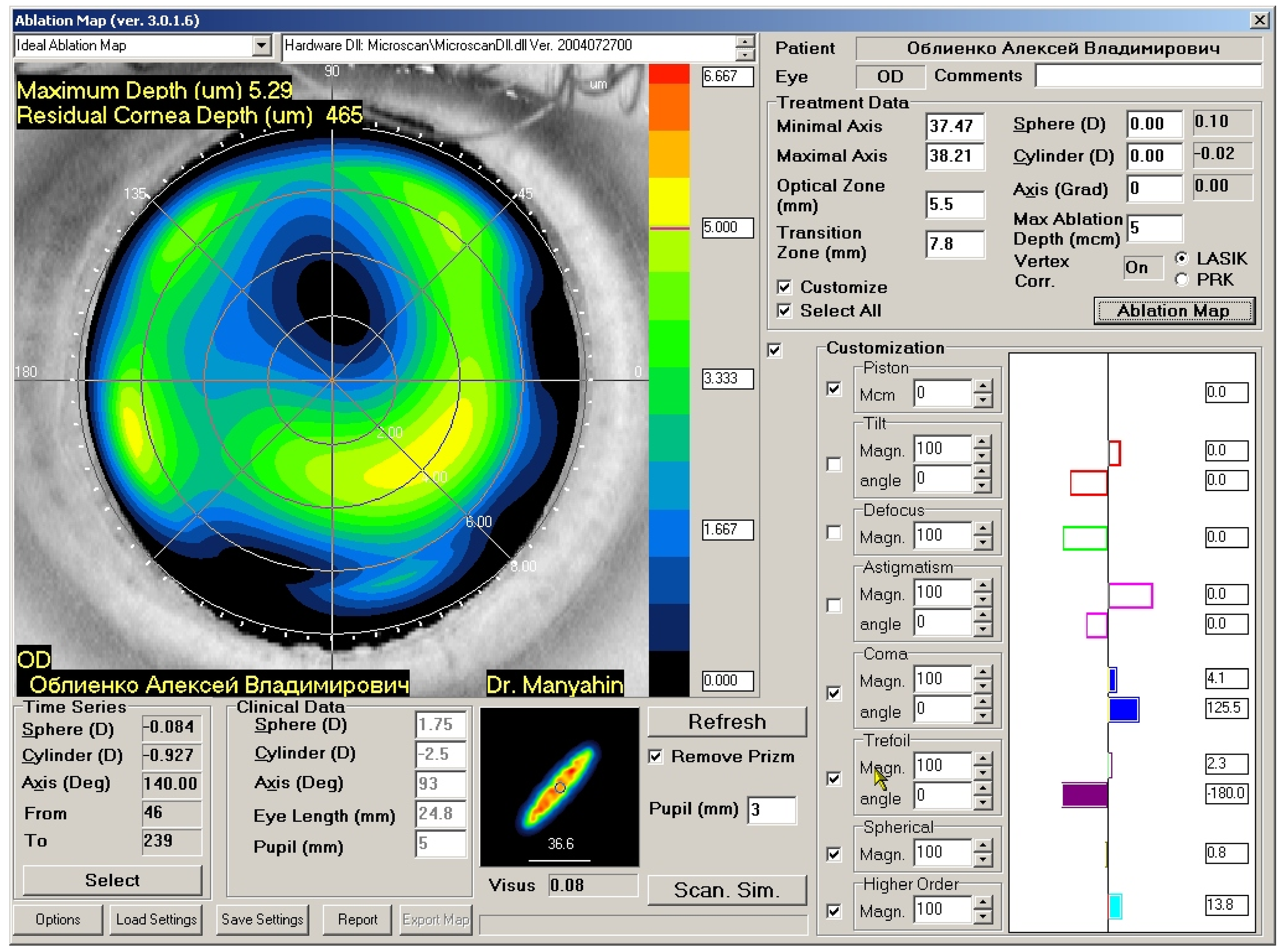

Fig. 4. Example of calculation of refractive laser surgery operation, based on the aberration data from MULTISPOT250

even when Seidel expression would fail.

The instrument is under clinical testing in Tambov branch of Federov Eye Center. Aberrometry data are used for calculations of refractive laser surgery operations. (See Fig. 4)

Conclusion:

We have found that dynamic aberrometry provides more accurate information on eye refraction than conventional techniques.

References:

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