

# Accuracy of wavefront aberrometry in cataract patients

Loss of optical media transparency reduces accuracy in clinical practice

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Wavefront aberrometry (WA) offers promising applications in ophthalmology and can provide valuable information in previously under-researched conditions including hyperopia and cataract-related reduced visual acuity (VA). In clinical settings, WA is frequently used to assess patients presenting for refractive surgery, and previous studies have demonstrated a high level of accuracy of WA measurements in comparison to those of manifest refraction (MR) and auto-refraction. However, the subjects of these studies have primarily been young, myopic and well-sighted patients, while in clinical practice the majority of patients presenting for cataract surgery are of advanced age, with ametropia and reduced VA.

As a patient's VA can be affected when WA is used as a basis for surgical treatment of pathological conditions (particularly if the measurements are less accurate in specific patient populations), Dr Stephan Linke, Dr Jan Hülle (University Medical Center Hamburg-Eppendorf, Germany) and colleagues decided to conduct a study to evaluate the accuracy of WA in comparison to MR in an older population awaiting cataract surgery.<sup>1</sup> The trial was intended to help the team determine if previous study results can be replicated in clinical practice and to establish which factors, if any, affect the accuracy of the refractive values as measured by WA.

## Assessing the eyes

Patients were classified into two groups. In the first group of eyes ( $n = 130$ ), mean patient age was 65.9 years (SD: 11.81 years), with average corrected distance visual acuity (CDVA) of 0.20 logMar (SD: 0.57), mean manifest sphere of 0.23 D (SD: 3.39 D) and manifest astigmatism of  $-1.25$  D (SD: 1.21 D). The second group of eyes ( $n = 28$ ) was the reference group: mean patient age was 33.9 years and mean VA was  $-0.1$  logMAR.

In the first group, the refractive errors were measured prospectively by WA and MR; for further analysis, refractive values were transformed into power vector components: spherical equivalent (SE) and Jackson cross cylinder at  $0^\circ$  and  $45^\circ$  (J0 and J45).

The researchers then applied statistical analyses — the 'limits of agreement' approach, regression analysis, correlation analysis and ANOVA — to compare the measured refractive values from both for each patient and for sub-groups of the whole population. The sub-groups were determined by ametropia, age or cataract-related reduced VA status. The results were compared to those from the second group of younger, healthy eyes.

"We had anticipated that WA would measure the same refractive values as MR, but that potential measurement differences between the devices would be explained either by the refractive state — hyperopia versus myopia — or by age. We also thought that the only impact of cataract on the results would be that more progressed forms of cataract would lead to more exaggerated differences between measurements taken on the separate devices," explained Dr Hülle. "However, some of the results we actually achieved were surprising, and were in fact contrary to previously published conclusions."

## The surprising results

The correlation between WA and MR measurements of SE was high in myopic eyes ( $r = 0.917$ ,  $p < 0.001$ ) and moderately high in hyperopic eyes ( $r = 0.800$ ,  $p < 0.001$ ). For all subjects, correlations between WA and MR were  $r = 0.742$  ( $p < 0.001$ ) for J0 and  $r = 0.760$  ( $p < 0.001$ ) for J45.

## In short...

Wavefront aberrometry (WA) offers promising applications in ophthalmology and can provide valuable information in previously under-researched conditions. Previous studies have demonstrated a high level of accuracy of WA in assessing patients presenting for cataract surgery, however, these patient groups have been primarily young, myopic and well-sighted, which may not be representative of clinical practice. Drs Hülle and Linke discuss results of a recent study evaluating the accuracy of WA in comparison to manifest refraction in an older population awaiting cataract surgery.

“Neither patient age nor VA had a significant effect on measurement differences. Further, mild to moderate cataract did not impact on measurement differences between the two devices, although more progressed cataract did seem to influence results,” noted Dr Hülle. “But across nearly all conditions, WA measured significantly higher myopic and astigmatic values than MR. Most of these effects were replicated in the reference group.”

The surprising results came when the researchers examined in depth the younger patients with clear media opacity.

“Our agreement ranges were far wider in general, calling into question whether WA and MR measurements are to be considered interchangeable in an older cohort of cataract patients,” said Dr Hülle. “In particular, this trend was more expressed in myopia than in hyperopia, which also stands in contrast to previous findings that reported the opposite.”

### Interpreting the results

According to Dr Linke, these unexpected results could potentially be explained by the higher heterogeneity of the patient population in this study as compared to previous trials, which is more reflective of everyday conditions in clinical settings. Therefore, these results could inform current clinical practice: as loss of optical media transparency will inherently reduce the accuracy of WA and as previous results on interchangeability — which had stemmed from optimal conditions in healthy eyes with little media opacity — cannot be directly transferred to other patient populations, clinicians might choose to apply what Dr Hülle terms ‘a certain degree of scepticism’ when applying WA to cataract patients, particularly in those with higher myopia and more progressed cataracts.

### Moving forward

“More work needs to be done

to reveal potential relationships between the cataract stage and the quality of WA maps — further studies are needed to define cut-off values for automated wavefront quality grading and intraoperative application of WA in refractive surgery,” Dr Linke recommended. “But we expect that the challenges for improving WA under more complicated conditions such as cataract and in an intraoperative setting will be informed by our research.”

For that purpose, the team is currently analysing intraoperative data from a WA prototype that was mounted on an operation microscope, with the aim of determining how the different steps of cataract surgery influence WA measures, WA quality and how accurately postoperative refraction can be predicted. There will also be a further examination of the effect of different forms of ametropia and the role of cyclotorsion. Beyond these topics, the team then plans to focus its future research on topics including:

- How might WA help to better predict IOL values by measuring refraction at different stages during cataract surgery?
- How does horizontal positioning of the patient alter WA refraction?
- On what factors could an intraoperative WA quality measurement rely?
- How would such a quality-grading correlate with an objective cataract grading?

“For these queries our study may serve as a reference in helping to clarify possible intraoperative chances and limits of WA,” concluded Dr Hülle and Dr Linke.

### Reference

1. J.O. Huelle *et al.*, *Graefes Arch. Clin. Exp. Ophthalmol.*, 2013;251:1163–1173.

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### Special contributors

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Dr Hülle and Dr Linke have indicated that they have no financial interests in the subject matter.