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Reports

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A Comparison of Short-Term Intraocular Pressure Fluctuation with Office-Based and Home Tonometry

Intraocular pressure (IOP) tends to be measured infrequently and only during office visits, which may result in failure to identify peak IOP and a reduction in ability to determine risk of glaucoma progression. Obtaining IOP measurements infrequently hinders the clinician's capacity to distinguish therapeutic effect from background IOP fluctuations and measurement imprecision.[1] Serial office-based tonometry can be used to obtain multiple measurements and to examine diurnal fluctuations, but it requires considerable resources, and obtaining measurements outside office hours is logistically difficult.

The recent introduction of a rebound tonometer (RT) for self-tonometry (Icare HOME; Icare, Oy, Finland) provides a possible alternative to serial office-based measurement.[2,3] Self-tonometry has the advantage of permitting a greater number of IOP measurements than traditionally feasible and allows patients to measure their own diurnal IOP curve.

We recently completed a prospective observational study comparing IOP fluctuations measured during office- and home-based rebound tonometry. The study included patients at Princess Alexandra Eye Pavilion, Edinburgh, United Kingdom, with a diagnosis of normal-tension glaucoma based on historic office-hour IOP measurements. Study methods were approved by the South-East Scotland Research Ethics Committee and adhered to the principles of the Declaration of Helsinki. Participants provided written informed consent.

Participants underwent a comprehensive ophthalmologic examination, with glaucoma defined by a glaucomatous abnormality to the optic nerve head or retinal nerve fiber layer on examination or OCT, with a repeatable defect on standard automated perimetry. Those meeting eligibility criteria were instructed to stop IOP-lowering medications for a washout period of up to 42 days, depending on the medication used. Patients in whom it was not deemed safe to stop medication were excluded.

After medication washout, IOP was measured in the office at 9:00 AM using the Ocular Response Analyzer (G3; Reichert, Buffalo, NY) to ascertain Goldmann-correlated IOP, corneal compensation IOP, and corneal hysteresis. A trained technician used the Icare HOME RT to measure IOP at 9:00 AM, 11:00 AM, 1:00 PM, and 4:00 PM. At each reading, the RT automatically obtains 6 measurements, discards the highest and lowest, and reports the mean of the remaining 4 measurements. Participants were taught how to measure their IOP using the RT with a standardized training protocol lasting up to 30 minutes[2] and were asked to measure their IOP at 9:00 AM, 11:00 AM, 1:00 PM, 4:00 PM, 8:00 PM, and 4:00 AM over the next 2 days. Intraocular pressure measurements, obtained from office-based tonometry using the RT, including mean, peak, and standard deviation, were compared with those from home-tonometry. All measurements were obtained while the patient was in the sitting position.

Sixty-four patients were recruited, among whom 50 (78.1%) were able to perform self-tonometry. Those able to perform self-tonometry were significantly younger (70.1 ± 8.6 years vs. 74.1 ± 7.5 years; $P = 0.030$). The clinical characteristics of participants are summarized in Table S1 (available at www.ophthalmologyglaucoma.org). Table S2 (available at www.ophthalmologyglaucoma.org) shows a comparison of IOP parameters obtained from office-based and home tonometry. Analyses were conducted for worse eyes, defined by standard automated perimetry mean deviation. Figure 1 summarizes mean, standard deviation, and peak IOP measured by office-based and home rebound tonometry. No significant difference was found in mean IOP from office measurements compared with home tonometry (14.5 ± 4.4 mmHg vs. 14.2 ± 4.8 mmHg; $P = 0.565$), and no difference was found in mean IOP on days 1 and 2 of home measurement (Table S2). Home monitoring showed higher short-term IOP fluctuation, with a standard deviation of 1.7 ± 1.9 mmHg with office-based measurements, compared with 3.2 ± 1.9 mmHg ($P < 0.001$ compared with office-based measurements) and 2.8 ± 1.6 mmHg ($P = 0.002$ compared with office-based measurements) for each day of home monitoring (Table S2). In addition, peak IOP was significantly higher with home monitoring (18.0 ± 6.9 mmHg on day 1 and 17.7 ± 5.7 mmHg on day 2, compared with 16.3 ± 5.0 mmHg in the office). Overall, no significant difference was found in mean IOP at 9:00 AM, 11:00 AM, 1:00 PM, or 4:00 PM from office measurements compared with day 1 of home monitoring. Measurements on day 2 were higher than office-based measurements only at 4:00 PM.

Bland-Altman plots examining the relationship between office-based and home IOP measurements showed an overall good level of agreement, with a mean difference of $1.2 - 0.08 \times$ average IOP and 95% limits of agreement of $\pm 2.46 \times (1.79 + 0.01 \times$ average IOP) (Fig S2, available at www.ophthalmologyglaucoma.org). At the sample average IOP of 14 mmHg, this equated to a mean difference of only 0.08 mmHg and 95% limits of agreement of ±4.75 mmHg. Good agreement also was found between IOP from home monitoring on consecutive days, with a mean difference of $-0.41 + 0.04 \times$ average IOP and 95% limits of agreement of $\pm 2.46 \times (0.91 + 0.03 \times$ average IOP). At an average IOP of 14 mmHg, this equated to a mean difference of only 0.15 mmHg and 95% limits of agreement of ±3.27 mmHg. Only 2 eyes showed a difference in mean IOP of more than 2 mmHg. Home monitoring revealed 19 patients (38%) showed peak IOP at 9:00 AM, 21 patients (42%) showed peak IOP at 11:00 AM, 20 patients (40%) showed peak IOP at 1:00 PM, 14 patients (28%) showed peak IOP at 4:00 PM, 11 patients (22%) showed peak IOP at 8:00 PM, and 13 patients (26%) showed peak IOP at 4:00 AM.

This study supports the feasibility of self-tonometry, demonstrating that IOP measurements obtained from home monitoring are similar to those obtained from office-based tonometry. Performing multiple measurements in the office is inconvenient and does not allow measurements easily outside working hours. Self-tonometry is an attractive alternative. We found that after a short training session, most patients could measure their IOP successfully and continue to do so at home. Overall, no difference was

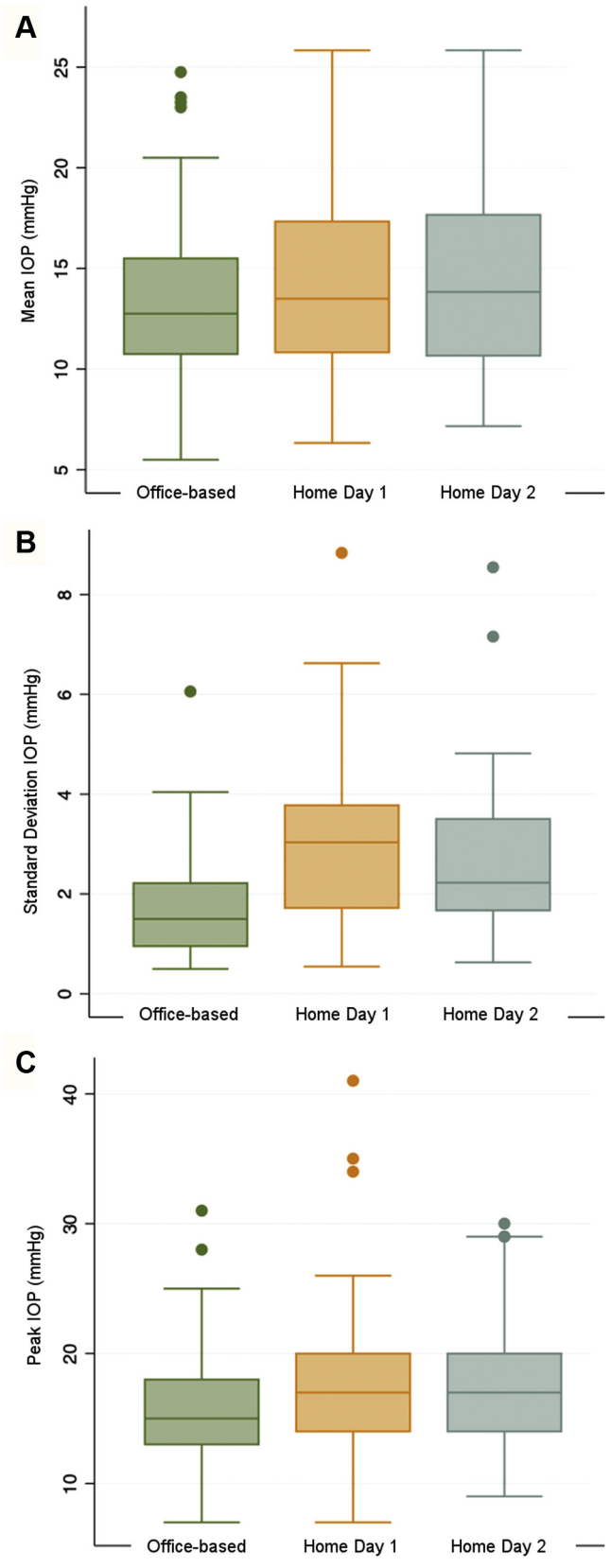

Figure 1. Box plots showing (**A**) mean, (**B**) standard deviation, and (**C**) peak intraocular pressure (IOP) measured during office-based and home rebound tonometry.

found in mean IOP from home and office testing, and 95% limits of agreement were within 5 mmHg. However, variations in peak and standard deviation IOP were found, with both being higher during home testing. Differences may have been the result of measurement error or genuine IOP fluctuation; however, the latter seems more likely and is consistent with previous observations that most patients experience peak IOP outside office hours.[3] Home monitoring may provide a means to better identify peak IOP and, in addition, could be used to decrease noise inherent in IOP measurement.[4]

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