

Clinical performance of non-contact tonometry by Reichert AT550[®] in glaucomatous patients

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Abstract

Measuring intraocular pressure (IOP) by non-contact tonometry (NCT) has been demonstrated to be a valid and reliable technique to be used in primary eye care; it is easier to use, it does not transmit infectious diseases, and it is not necessary to use anaesthetic or staining eye drops. Recently, a new NCT device has showed an excellent level of agreement with Goldmann tonometry, but there are no records of its performance in glaucomatous eyes. To rectify this, IOP was measured in twenty-two patients (44 eyes) receiving medical treatment to control elevated IOP, with AT550[®] and Goldmann tonometry. Mean values of IOP were 18.98 ± 2.77 and 19.08 ± 3.02 mmHg using Goldmann and AT550[®], respectively. Plots of differences against means displayed good agreement (mean difference \pm limits of agreement, -0.09 ± 3.30); this value was not significantly different from zero (*t*-test for dependent samples, $p = 0.709$). In conclusion, IOP values as measured with the AT550[®] NCT are clinically comparable with those obtained with Goldmann tonometry in glaucomatous patients. This validates this NCT not only for screening of IOP but to follow-up glaucomatous patients with a rapid, non-invasive method.

Keywords: intraocular pressure, glaucoma, Goldmann tonometry, non-contact tonometry, Reichert AT550, reliability

Introduction

Non-contact tonometers (NCT) are widely and increasingly used in optometric practice, being a rapid and convenient method to measure intra-ocular pressure (IOP). As a local anaesthetic is not needed, NCT can be used as a screening instrument in preference to the Goldmann applanation tonometer and the readings are

largely independent of the operator (McCaghrey and Matthews, 2001).

Such instruments have demonstrated a good level of agreement with Goldmann applanation tonometry (AT), the 'gold standard' in clinical practice. New NCT are being delivered to the market, and comparisons with applanation AT are of clinical interest to determine their suitability for IOP measurements in normal eyes and in eyes with glaucoma.

Recently, the authors have tested the accuracy of a new NCT, the Reichert AT550[®] (Depew, NY, USA) in a young healthy population. The experiment included another NCT and two AT; the Goldmann, and its hand-held version, the Perkins tonometer. Results showed a surprisingly high level of agreement between the AT550[®] and Goldmann tonometer, concluding that readings of IOP with the AT550[®] NCT are clinically comparable with those obtained with Goldmann tonometry in a population with IOP within the normal range (Jorge *et al.*, 2002).

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However, the commonest application of tonometry is the detection and follow-up of patients undergoing medical treatment to control elevated IOP, and comparisons of NCT with Goldmann AT in glaucomatous patients has not been a popular topic so far. Some experiments published on this subject generally displayed poor agreement (Mackie *et al.*, 1996; Jara *et al.*, 2000). Another study demonstrated that all tonometers, including various NCT and the hand-held version of the Goldmann tonometer, were less accurate when the IOP was markedly elevated (Abrams *et al.*, 1996). So, investigating the reliability of AT550[®] in patients with raised IOP is important to assess the suitability of this upgraded version of NCT in the follow-up of patients with elevated IOP.

This study was therefore conducted to establish the accuracy of the new AT550[®] NCT against Goldmann AT in the assessment of IOP in patients suffering from different forms of glaucoma.

Subjects and methods

Forty-four eyes from 22 patients with open-angle, pigmentary, or capsular glaucoma, or ocular hypertension, who had been receiving topical medication for at least three months of monotherapy with latanoprost 0.005% administered once daily or monotherapy with carteolol 2% instilled twice daily were recruited from an ophthalmologic private clinic in the north of Portugal. Measures of IOP were taken after informed consent was obtained from each patient. There were 11 male (mean age 64 ± 15.2) and 11 female (mean age 63 ± 16.2) patients. Both eyes from the same patient were considered as 'independent samples' because of IOP asymmetries, which are significantly larger when considering glaucoma populations. This fact supports the use of each eye as separate samples (Mackie *et al.*, 1996). The study protocol was reviewed by the Scientific Committee of the Faculty of Science at the University of Minho (Portugal).

Non-contact tonometry was performed first in order to avoid the documented effect of aqueous humor evacuation by anterior chamber compression with AT (Krakau and Wilke, 1971; Jia *et al.*, 2000; Deuter *et al.*, 2002). Different examiners performed measurements with NCT and Goldmann AT, the second being masked for values obtained with NCT five minutes before.

Goldmann AT was performed by one experienced observer routinely assessing IOP in the clinic. Following topical anaesthesia (2.5 mg mL^{-1} oxybuprocaine and 4 mg mL^{-1} fluorescein), two successive measurements were obtained. The drum was reset to 10 after each reading and the biprism was disinfected with 3% hydrogen peroxide between subjects. For the Goldmann tonometer, a magnification of 10 \times was used in the slit-

lamp in conjunction with a cobalt blue filter to detect the applanation end-point.

The NCT was performed by a different observer, the measurements were taken in the automatic mode to minimize intervention of the operator in the reading process; the average of three consecutive readings was recorded for subsequent analysis.

Data was analysed using the statistical package SPSS version 11.0. The bias was assessed statistically as the mean of the differences compared with zero. The hypothesis of zero bias was examined by a Student's paired *t*-test. Agreement was assessed using Bland and Altman approach (Bland and Altman, 1986).

Results

Table 1 summarizes mean IOP along with their respective SD for measurements done with each instrument. NCT slightly overestimates IOP on average but values of IOP measured by Goldmann and AT550[®] were not statistically different ($p = 0.709$).

Table 1. Descriptive statistics (mean, S.D.) for NCT (AT550[®], Reichert) and Goldmann AT

	Glaucomatous ($n = 44$)	
	Mean	S.D.
AT550 [®]	19.08	3.02
Goldmann	18.98	2.77
Total	19.04	2.88

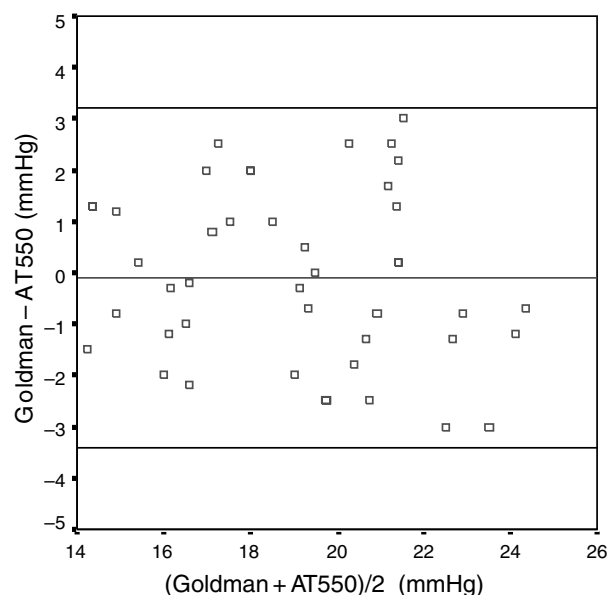


Figure 1. Plots of difference vs mean of IOP values obtained with NCT (AT550[®], Reichert) and Goldmann AT.

Figure 1 represents the agreement between measurements obtained with NCT and Goldmann AT. Mean difference and 95% confidence interval was -0.09 ± 3.30 . Significant spread of data is observed around mean difference line, which seems to be dependent on the value of IOP, with more scatter of data as IOP increases.

Comparisons between right and left eyes showed higher values for right eye with both instruments, presenting higher mean inter-eye difference with NCT than Goldmann, 0.9 against 0.43 mmHg, respectively.

Discussion

The use of diagnostic drugs is forbidden for optometrists in many European countries, making IOP evaluation difficult in everyday optometric practice. In such a situation, early screening and referral of glaucoma patients is unlikely, until a hospital referral by a general medical practitioner, which usually happens too late for glaucoma patients. NCT does not require contact between the instrument and the eye, with a much-reduced risk of cross-contamination compared with AT. Additionally, it is rapid, and does not need special training of the observer to obtain reproducible measurements, being largely independent of the operator criteria and experience with the technique. For these reasons, non-invasive methods for the measurement of IOP have gained popularity within the optometric community.

The AT550® is the latest version of the Reichert NCT. Authors obtained a good level of agreement between NCT by the new AT500® and AT by Goldmann tonometer on a young, healthy population of university students with IOP measurements within the range of 9–18 mmHg (Jorge *et al.*, 2002).

In the present study, close agreement was found between both instruments for a population with elevated IOP. Limits of agreement between Goldmann and NCT significantly improve performance of previous NCT. For all glaucomatous patients, AT550® NCT measured IOP values within ± 3.30 mmHg, representing a significant reduction in the bias of other instruments which show double the error of AT550® (Mackie *et al.*, 1996). Present results agree with Katsushima *et al.* (2002) who found even closer agreement between AT and NCT. Close analysis of graphic data shows a trend for more scatter of data for higher IOP as had been previously observed by McCaghey and Matthews (2001).

Another point to discuss is the inclusion of both eyes in the study. In a previous paper authors have confirmed that in young healthy patients there is no IOP asymmetry between right and left eyes; making it necessary to use just one eye from each subject to

ensure independence of data (Jorge *et al.*, 2002). These results agree with conclusions of Pointer (1997), after a retrospective analysis of IOP values recorded from right and left eyes of non-glaucomatous subjects using NCT. However, right and left eyes from glaucomatous patients displayed clinically appreciable asymmetry in IOP values with both Goldmann tonometry and NCT. The authors, in agreement with Mackie *et al.* (1996), consider that this fact supports the use of each eye from the same patient as a separate sample.

The present study demonstrates that new NCTs offer good levels of reliability when measuring IOP in patients affected by glaucoma. This will certainly increase the ability of optometric practitioners to develop more accurate and efficient work in the detection and appropriate referral of patients with increased IOP. Another field of interest will be the shared care of patients undergoing medical treatment for glaucoma, particularly in the periodic evaluation of IOP.

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References

- Abrams, L. S., Vitale, S. and Jampel, H. D. (1996) Comparison of three tonometers for measuring intraocular pressure in rabbits. *Invest Ophthalmol. Vis. Sci.* **37**, 940–944.
- Bland, J. M. and Altman, D. G. (1986) Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet* **1**, 307–310.
- Deuter, C. M., Schlote, T., Hahn, G. A., Bende, T. and Derse, M. (2002) Measurement of intraocular pressure using the Tono-Pen in comparison with Goldmann applanation tonometry – a clinical study in 100 eyes. *Klin. Monatsbl. Augenheilkd.* **219**, 138–142.
- Jara, P. M., Lopez, T. A., Duce, T. S., Navas, S. V., Gonzalez, S. M. and Toledano, F. N. (2000) Comparative study of pneumotonometer and Goldmann tonometer for screening high intraocular pressure in primary care. *Aten. Primaria* **25**, 493–496.
- Jia, L., Cepurna, W. O., Johnson, E. C. and Morrison, J. C. (2000) Effect of general anesthetics on IOP in rats with experimental aqueous outflow obstruction. *Invest Ophthalmol. Vis. Sci.* **41**, 3415–3419.
- Jorge, J., Diaz-Rey, J. A., Gonzalez-Meijome, J. M., Almeida, J. B. and Parafita, M. A. (2002) Clinical performance of the Reichert AT550: a new non-contact tonometer. *Ophthalmic Physiol. Opt.* **22**, 560–564.
- Katsushima, H., Stone, A., Takeda, A., Okazaki, H., Adachi, J., Funahashi, K. and Maruyama, I. (2002) Effect of

- tonometry on a glaucoma population study. *Nippon Ganka Gakkai Zasshi* **106**, 143–148.
- Krakau, C. E. and Wilke, K. (1971) On repeated tonometry. *Acta Ophthalmol. (Copenh)* **49**, 611–614.
- McCaghrey, G. E. and Matthews, F. E. (2001) The Pulsair 3000 tonometer—how many readings need to be taken to ensure accuracy of the average? *Ophthalmic Physiol. Opt.* **21**, 334–338.
- Mackie, S. W., Jay, J. L., Ackerley, R. and Walsh, G. (1996) Clinical comparison of the Keeler Pulsair 2000, American Optical MkII and Goldmann applanation tonometers. *Ophthalmic Physiol. Opt.* **16**, 171–177.
- Pointer, J. S. (1997) Intraocular pressure asymmetry is not a clinically-significant feature when using the PULSAIR non-contact tonometer. *Ophthalmic Physiol. Opt.* **17**, 449–455.