

Intraocular pressure in silicon-oil tamponaded eyes using a non-contact pulse synchronous tonometer: IOP measurement in vitrectomized and silicon-oil tamponaded eyes by NT – 4000

Vetrugno Michele, Cardascia Nicola, Vischi Antonio, Recchimurzo Nicola, Sborgia Carlo

[Abstract] Objective To assess the reliability of intraocular pressure (IOP) measurement by means of Nidek-NT – 4000 tonometer in vitrectomized and silicon-oil tamponaded (VSOT) eyes. Methods IOP was measured by means of Nidek-NT – 4000 and compared with standard Goldmann applanation tonometer (GAT) in 36 consecutive VSOT eyes and 36 normal eyes. Results In VSOT and normal eyes Nidek-NT – 4000 showed agreement with GAT (VSOT eyes mean difference: 1.83 ± 2.64 , $P = 0.55$; correlation: $P < 0.0001$, $r = 0.95$; Normal eyes mean difference: 1 ± 2.8 , $P = 0.42$; correlation: $P = 0.0045$, $r = 0.69$). Differences were similar between groups ($P = 0.81$). Conclusions Nidek-NT – 4000 tonometer offers a new affordable method to measure IOP in vitrectomized and silicon-oil tamponaded eyes.

[Key words] non-contact tonometer; silicon oil; vitrectomy

INTRODUCTION

Measurement of intraocular pressure (IOP) plays an important role not only in the detection and management of glaucomatous conditions but also in the postoperative management of corneal, lenticular, and vitreoretinal diseases, where non-contact instruments might be preferable to avoid infectious complications^[1]. In 1967 Bynke investigated the influence of ocular blood pulse on IOP fluctuation. The rapid variation in IOP corresponds to an ocular volume change that occurs as a bolus of arterial blood enters the eye during systole^[2,3]. Since the Non-Contact Tonometer (NCT) measurement is usually made in about 1/500 of the cardiac cycle (1 ~ 3 ms) and is random with respect to the phase of the cardiac cycle, the ocular pulse becomes a significant source of variability and produces a spread of 1 ~ 3 mm Hg^[4,5]. Even if those issues are applicable in normal eyes^[6], different conditions were detected in eyes which underwent vitreoretinal surgery and were gas tamponaded^[7]. In 1990 Hoshi revealed silicon oil has some effects on the dynamics of the intraocular fluid in operated eyes, reducing the amplitude of the diurnal variation^[8]. Later Gramer shown

silicon oil may induce secondary glaucoma^[9] and Al-Jazzaf reported a chronic intraocular pressure elevation in silicon oil tamponaded eyes^[10].

Recently Nidek Co. Ltd (Gamagori, Japan) introduced a new NCT: the NT – 4000. The limitations related to ocular blood pulse were avoided by the modulation and synchronization of the measurement with the blood pulse detected in front fore rest. Considering the upcoming low-invasive diagnostic and therapeutic procedures we investigate the reliability of Nidek NT – 4000 as low-invasive non-contact measurement of IOP in vitrectomized and silicon-oil filled eyes.

METHODS

Thirty-six consecutive non-diabetic patients affected by primary retinal detachment were enrolled in our study. All of them underwent vitrectomy and were tamponaded with silicon oil (1000 cs), without any scleral buckling. Peripheral vitreous shaving was carried out in all eyes. Scleral buckling procedure was not performed in any eye. The study was thoroughly discussed with each patient, and informed consent was obtained from all participants, after Investigational Review

Board approval was obtained. Thirty-two eyes were pseudophakic, the remaining were phakic. To avoid any interference related to corneal thickness determined by surgical oedema, IOP measurements were recorded about 1 month [(1.3 ± 0.5) months, range 0.9 ~ 1.9 months] after surgery. All IOP measurements were performed between 9:00 and 11:00. Yaoeda K calculated IOP synchronizing the measures of NT - 4000 with the peak, the trough and the middle of pulse, finding a good correlation among all the pulse-phases^[6]. Therefore, IOP was measured by means of NT - 4000 considering the middle value because it may represent a mean estimation of pulse-phases. Three consecutive measurements were taken and averaged by one examiner (MV). A different examiner (NC) performed Goldmann applanation tonometry within 15 minutes from the first. Three consecutive GAT measurements were obtained and averaged, taking care to avoid prolonged contact between the Goldmann tip and the cornea so the IOP would remain unaffected^[11]. In the same patient the untreated eye was valued as control. Results were analyzed with regression analysis obtained using Graphpad InStat (GraphPad Software, Inc.). Multivariate analysis of variance (ANOVA) for repeated measurements was used to compare the preoperative and postoperative IOP measurements between the 2 tonometers. A P value less than 0.05 was considered statistically significant.

RESULTS

The mean age of the 27 men and 9 women was (56 ± 9.5) years. In VSOT eyes the mean IOP value was (19.09 ± 8.58) mm Hg with NCT, and (17.27 ± 8.05) mm Hg with GAT. The mean difference was (1.83 ± 2.64) mm Hg (Figure 1). No statistical difference was found between the two mean measurements (paired t-test $P = 0.55$, CI: $-8.05 \sim -4.4$). Pearson's correlation calculated between the values of both tonometry was 0.95 with a significance of 0.0001 (Figure 2). The same procedure was applied in the untreated eyes. Mean IOP was (15.69 ± 3.55) mm Hg with NCT, while GAT shown (14.67 ± 2.92) mm Hg (Figure 1). The mean difference was (1 ± 2.8) mm Hg, with no statistical significance (paired

t-test $P = 0.42$, CI: $-3.58 \sim 1.52$). The Pearson's correlation was 0.69 with a significance of 0.0045 (Figure 3). The differences recorded between the two measurement, in both study groups, were comparable (Unpaired t-test $P = 0.42$, CI: $-1.23 \sim 2.84$).

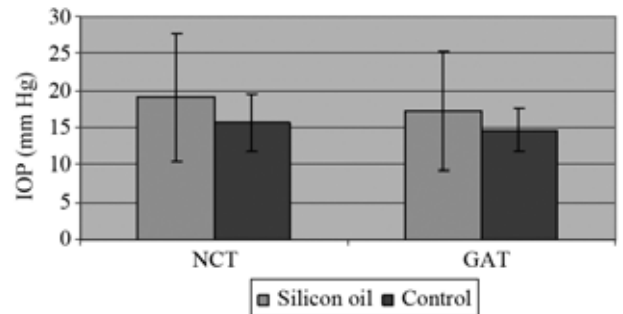


Figure 1 IOP measurements in vitrectomized silicon oil tamponaded eyes detected by means of Goldmann applanation tonometer (GAT) and non-contact tonometer (NCT)

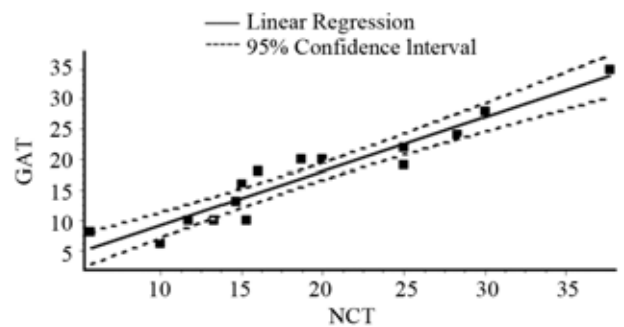


Figure 2 Correlation between IOP measurements (mm Hg) in vitrectomized silicon oil tamponaded eyes detected by means of Goldmann applanation tonometer (GAT) and non-contact tonometer (NCT). Pearson's coefficient of correlation 0.95, $P = 0.0001$

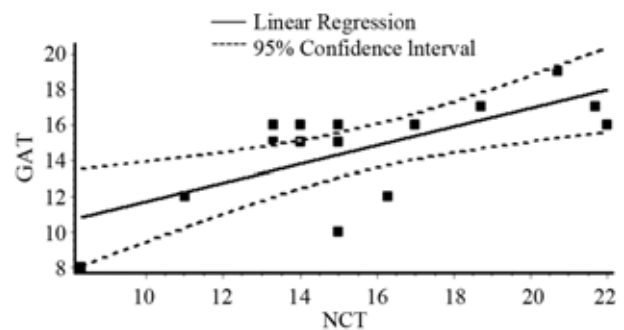


Figure 3 Correlation between IOP measurements (mm Hg) in normal eyes detected by means of Goldmann applanation tonometer (GAT) and non-contact tonometer (NCT). Pearson's coefficient of correlation 0.69, $P = 0.0045$

DISCUSSION

In normal and vitrectomized silicon-oil tamponaded eyes, we observed a small non-significant difference between the measurements provided by the two techniques. Those differences were about 1 mm Hg in normal eyes and 1.8 mm Hg in vitrectomized eyes with higher values in the measurements detected by NCT NT – 4000. According to previous reports this could be referred to increased outflow of aqueous humour, induced by the durative appplanation of GAT (approx 2 s.) compared to the rapid and non-contact detection of NCT (approx 1 ~ 3 ms^[12]). The differences of IOP between VSOT and normal eyes were similar using both tonometers. Good correlation was found between the measurements in each group, even if a stronger correspondence was found in the silicon-oil tamponaded eyes, probably due to the reduced amplitude of the diurnal variation of IOP recorded in those eyes^[8]. Even if elevated IOP in silicon-oil tamponaded eyes is usually managed by silicon-oil removal^[13]. Several situations could be controlled by topical therapy and could benefit to a precise IOP measurements. While NCT measurements of IOP are often affected by ocular pulse, induced by arterial pulse, vasomotor waves, respiration, basal IOP, NT – 4000 overcomes those sources of error providing a more precise measurement of IOP synchronized on ocular pulse.

In conclusion, the results of this study suggest the applicability and reliability of the NT 4000 non-contact tonometer in normal and vitrectomized and silicon oil tamponaded eyes.

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