# Intraocular Pressure Changes in Pseudoexfoliation Syndrome with Icare Tonometer in Supine and Sitting Position

## Psödoeksfoliasyon Sendromunda İcare Tonometre ile Oturur ve Yatar Pozisyonda Göz İçi Basıncı Değişimleri*

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**ABSTRACT**

**Purpose:** To compare intraocular pressure (IOP) changes between sitting and supine position in individuals with pseudoexfoliation syndrome (PXS) and healthy volunteers.

**Materials and Methods:** Fifty five eyes with PXS and 49 eyes of healthy individuals were included in this prospective, controlled study. Slit lamp examination, gonioscopy and IOP measurement with iCare tonometer (ICT) in sitting and supine positions were performed to all patients in both groups.

**Results:** Mean age was 67.3 years in PXS group and 66.3 years in control group (p=0.432). Mean IOP in sitting position with ICT was 16.2±3.4 mmHg in PXS group and 16.7±2.9 mmHg in the control group (p=0.368). Mean IOP with GAT was 0.4 mmHg higher than ICT measurements in PEX group (p=0.055). Mean IOP with GAT was 0.32 mmHg higher than ICT measurements in control group (p=0.207). Mean IOP measured with ICT in supine position was 19.9±4.1 mmHg in PXS group and 19.0±3.2 mmHg in control eyes (p=0.348). We noticed that mean IOP rise was 3.65 mmHg in PXS group and 2.25 mmHg in the control group in supine position (p<0.001, p<0.001; respectively). When compared with the control group, IOP rise in supine position was statistically significant in PXS group (p<0.001).

**Conclusion:** IOP rises significantly in supine position both PXS and control groups, but this increase is more in PXS groups. IOP measurement with ICT is reliable and practical for supine and sitting body positions.

**Key Words:** Pseudoexfoliation syndrome, supine position, iCare, intraocular pressure.

**ÖZ**

**Amaç:** Sağlıklı ve psödoeksfoliasyon sendromlu (PXS) bireylerde oturur ve yatar pozisyondaki göz içi basıncı (GİB) değişikliklerini karşılaştırmak.

**Gereç ve Yöntem:** Prospektif ve kontrol gruplu bu çalışmaya PXS olan 55 göz, sağlıklı 49 göz dahil edildi. Her iki gruba yarıklı lamba muayenesi, gonyoskopi ve iCare tonometre (ICT) ile oturur ve yatar pozisyonda GİB ölçümleri yapıldı.

**Bulgular:** Yaş ortalaması PXS grubunda 67.3, kontrol grubunda 66.3 yıl idi (p=0.432). ICT ile oturur pozisyondaki GİB ortalaması PXS grubunda 16.2±3.4 mmHg ve kontrol grubunda 16.7±2.9 mmHg idi (p=0.368). PXS grubunda GAT ile ölçülen GİB, ICT ile ölçülenden 0.4 mmHg daha yüksekti (p=0.055). Kontrol grubunda GAT ile ölçülen GİB, ICT ile ölçülenden 0.32 mmHg daha yüksekti (p=0.207). ICT ile yatar pozisyondaki GİB ortalaması PXS grubunda 19.9±4.1 mmHg ve kontrol grubunda 19.0±3.2 mmHg idi (p=0.348). Ortalama GİB artışının, PXS grubunda 3.65 mmHg ve kontrol grubunda 2.25 mmHg olduğunu saptadık (sırasıyla p<0.001, p<0.001). Yatar pozisyondaki GİB artışı PXS grubunda, kontrol grubu ile kıyaslandığında istatistik açıdan anlamlı derecede farklı idi (p<0.001).

**Sonuç:** GİB hem PXS grubunda hem de kontrol grubunda yatar pozisyonda anlamlı şekilde artmaktaydı, ancak bu artış PXS grubunda daha fazla idi. ICT ile GİB ölçümleri, oturur ve yatar vücut pozisyonları için güvenilir ve pratiktir.

**Anahtar Kelimeler:** Psödoeksfoliasyon sendromu, yatar pozisyon, i-Care, göz içi basıncı.

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## INTRODUCTION

Although glaucoma is a multifactorial disease, elevated intraocular pressure (IOP) is still the most important known risk factor.[1] The IOP level and its fluctuations seem to play a role in the development and progression of disease, even in cases with normal pressures.[1,2] Different systemic and local factors are thought to play a role on IOP fluctuations. Going from upright to horizontal or inverted body positions may cause significant rise on IOP.[3-6] Although there are significant personel variabilities, the magnitude of the IOP change secondary to body position is greater in glaucomatous eyes.[7-11] As patients usually spend a significant portion of their lives in the horizontal position, mainly during sleep, this is highly relevant.

Elevated IOP is a well-defined risk factor for glaucoma, and we target to decrease IOP in all our treatment regimens, so that reliable IOP measurement is crucial for both diagnosis and management of glaucoma.[12] The iCare rebound tonometer (RBT; iCare TA01; Tiolat, Helsinki, Finland) is a hand-held, lightweight, and contact tonometer which uses the impact rebound principle to measure IOP.[13] It consists of two coaxial coils that project a magnetic probe towards the cornea and detect the deceleration of the probe when it contacts with the eye.[14] The deceleration speed correlates with IOP. For example, the higher the IOP, the shorter is the duration of impact. The main advantages of this tonometric method are that the instrument is quick, easy to use, and economical; additionally slit lamp, topical anesthesia, general anesthesia or sedation are not required. It facilitates measuring IOP in noncompliant or physically disabled individuals and children.

Pseudoexfoliation is a condition in which a whitish-grey amiloid-like material of uncertain origin is deposited on surfaces within the anterior segment of the eye: lens, iris, zonules, and cilliary processes. Pseudoexfoliation is recognised by the typical appearance of these deposits on the anterior surface of the pupil margin, corneal endothelium and anterior chamber angle.[15] PXS is an important ocular manifestation of a systemic disorder, and the most identifiable cause of open-angle glaucoma.[16] Markedly elevated IOP and an open angle is common in this syndrome. While not all patients with pseudoexfoliation will develop glaucoma, it is impossible to predict which patients with PXS will develop optic nerve damage and vision loss.[17,18]

It's well known that chronic diseases and senility may restrict mobility and disable them over 50 years of age.[19] Most of the time our patients have additional systemic diseases such as osteoporosis, stroke and obesity or some of our patients are in pediatric age group who cannot cooperate to slit lamp examination. Because IOP is the only quantifiable parameter of glaucoma we have to monitor IOP of these patients with any of a reliable method, too. Devices which can measure IOP in all body positions independent to a slit lamp may be an alternative for monitoring these patients.

We aimed to compare IOP changes between standard examination position "sitting position" and "supine position'' in individuals with PXS and healthy volunteers in the same age group in this study.

## MATERIALS AND METHODS

This is a prospective and controlled study performed at Izmir Bozyaka Education and Research Hospital. It was designed in accordance with the principals of the Helsinki Declaration. Approval for data collection and analysis was obtained from the ethics committee of the hospital, all patients provided informed consent. Fifty five eyes of 55 patients with PXS and 49 eyes of 49 healthy individuals were selected from patients who attended to our ophthalmology outpatient department for routine refraction correction. All patients in both groups underwent anterior segment and fundus examination with slit lamp biomicroscopy. Gonioscopy and IOP measurements were performed with Goldmann applanation tonometer (GAT, Haag-Streit AG, Bern, Switzerland) at 9 am. IOP measurements were repeated in sitting and supine position with ICT in both groups at between 9 o'clock and 10 o'clock in the morning. Patients with IOP lower than 22 mmHg and grade 3 or 4 iridocorneal angle according to Shaffer Classification were included to the study. Optical coherence tomography (Cirrus HD OCT; Carl Zeiss Meditec Inc, Dublin, CA.USA) was performed to all patients. Visual field analyses (Humphrey Field Analyzer 750i, Carl Zeiss Meditec Inc, Dublin, CA. USA) were performed twice times to all patients. It was considered a normal visual field analysis if mean deviation (MD), pattern standard deviation (PSD) and glaucoma hemifield test (GHT) values were in the 95% confidence range Exclusion criterions were spherical refraction error higher than ±5D, cylindrical refraction error higher than ±3D, previous intraocular surgery, ocular inflammation, posterior synechia, phacodonesis, iridodonesis, orthostatic hypotension, hypertension, overweight (BMI>25) and cardiopulmonary disease blocking to lie in supine position for 5 minutes, usage of topical medication except artificial tear drops. IOP was measured by the same ophthalmologist firstly with ICT in sitting position. Afterwards all patients were laid down in supine position for 5 minutes, at the end of the period IOP measurements were repeated with ICT in supine position. Average of the 6 measurements was recorded as ICT value of IOP. Measurements were repeated when disparities higher than 3 mmHg on IOP were detected.

In this study, data were analyzed using the statistical package SSPS v.15.0. Paired independent samples student t-tests and Pearson correlation analyze were used for statistical analyses and a p-value of $<0.05$ was considered statistically significance.

## RESULTS

Thirty two patients (58.1%) were female, 23 (41.9%) were male in PXS group and 29 (59.1%) were female, 20 (40.9%) were male in control group. There was no statistically significant difference between groups in respect to gender (p=0.918). Mean age was 67.3 (55-80) years in PXS group and 66.3 (52-79) years in control group (p=0.432).

MD was -0.19±1.78 decibel (dB) and PSD was 1.76±0.94 dB in PXS group while MD was -0.19±1.79 dB and PSD was 1.70±0.25 dB in the control group; the difference was not significant (respectively p=0.748, p=0.763). The glaucomatous damage was not detected in any of the patients. Mean IOP measured with GAT was 16.6±3.1mmHg in PXS group and 17.1±2.7 mmHg in control group and there was no statistically significant difference between groups (p= 0.657). Mean IOP measured with ICT in sitting position was 16.2±3.4 mmHg in PXS group and 16.7±2.9 in control group and the difference between groups was not significant (p=0.368). Mean IOP measured by ICT in supine position was 19.9±4.1 mmHg in PXS group and 19.0±3.2 in control eyes and there was no statistically significant difference between groups (p=0.348). These findings were shown in table 1.

Mean IOP in supine position was 3.65 mmHg higher than IOP values in sitting position in PXS group and IOP in supine position with ICT was 2.25 mmHg higher than sitting position in the control group. In both, the difference was statistically significant (p<0.000, p<0,000, respectively). When compared with the control group, sitting and supine position IOP change was significantly higher in the PXS group (independent sample test, p<0.000). IOP values measured with ICT in sitting and supine positions were significantly different and highly correlated in both study groups (r=0.794, p<0.000 in PXS group and r=0.879, p<0.000 in control group). IOP changes between sitting and supine position were not correlated with the age in both groups (Pearson correlation analyze, r=-0.058, p=0.674 in PXS group, r=0.146, p=0.318 in control group).

Mean IOP with GAT was 0.4 mmHg higher than ICT measurement in PEX group (p=0.055) (Figure 1). Mean IOP with GAT was 0.32 mmHg higher than iCare tonometer measurement in control group (p=0.207) (Figure 2). The differences were not statistically significant (Table 2). IOP measurement differences were highly correlated between GAT and ICT in both PEX and control groups (r=0.902, p<0.001; r=0.801, p<0.001, respectively, Pearson correlation analyze).

## DISCUSSION

Several theories have been proposed to clarify the mechanism of IOP fluctuations related to postural changes. Friberg et al.,[20] suggested that the increase of episcleral venous pressure in supine position results in decrease of aqueous outflow from Schlemm pathway and causes IOP elevation. Longo et al.,[21] suggested that the rise of choroidal blood volume in supine position is the cause of IOP rise. However, these hypotheses may be insufficient to explain the mechanism of extremely different IOP elevation magnitudes between both eyes. Actually the exact mechanism of postural changes in IOP is still unclear, so further studies are needed.

Jorge et al.,[22] were compared IOPen and ICT with GAT and they reported that ICT is a reliable device for monitoring IOP. Nakakura et al.,[23] measured IOP with four different portable tonometers on healthy volunteers in supine position and evaluated their confidence for IOP measurement in supine position. IOP measurements with ICT were higher than Kowa hand-held applanation tonometer measurements in supine position in case of IOP values greater than 13 mmHg, this difference was statistically significant (p=0.001). However the researchers stated that ICT measurements are reliable for clinical practice, despite higher results in IOP values bigger than 13 mmHg, than Kowa hand-held applanation tonometer. We used ICT for IOP measurements in our study basis of ICT measurements as reported in the recent clinical trials. However, the researches about the effect of CCT to measurements of IOP with ICT are controversy. While Rao et al.,[24] showed that ICT is affected from CCT as GAT, Poostchi et al.,[25] showed that corneal rebound tonometer readings are influenced by CCT whereas scleral rebound tonometer readings are of no value. Cagatay et al.,[26] found that ICT is affected by CCT in the IOP measurements of high myopes. Chui et al.,[27] determined that Rebound tonometry is affected by corneal properties including CH and CRF but not corneal thickness.

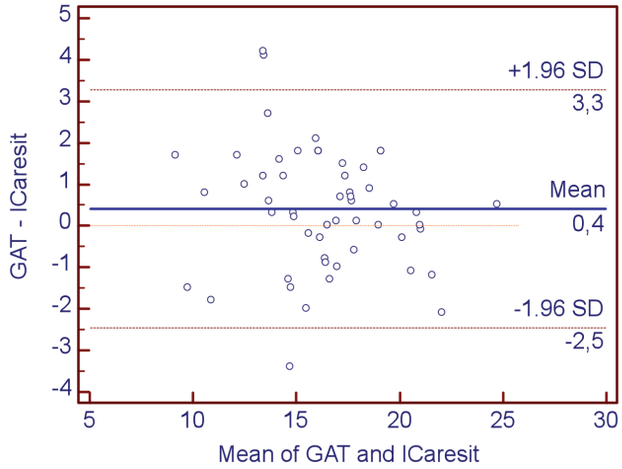


*Figure 1: Bland-Altman test for correspondence of ICT and GAT measurements of IOP in PEX group. The mean difference of IOP was 0.4 mmHg, IOP values were between 3.3 mmHg and -2.5 mmHg.*

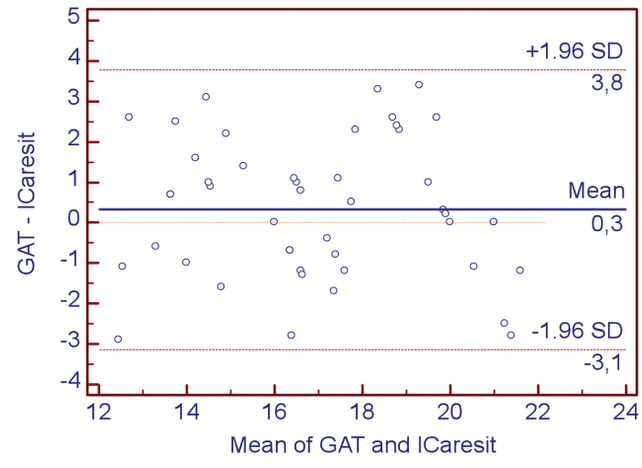


*Figure 2: Bland-Altman test for correspondence of ICT and GAT measurements of IOP pressure in control group. The mean difference of IOP was 0.32 mmHg, IOP values were between 3.8 mmHg and -3.1 mmHg.*

***Table 1:*** *IOP values in pseudoexfoliation and control groups in sitting and supine positions.*

| | ICT sitting (mmHg) | ICT supine (mmHg) | p value* |
|---|---|---|---|
| Pseudoexfoliation group (n=55) | 16.2±3.4 | 19.9±4.1 | p<0.001 |
| Control group (n=49) | 16.7±2.9 | 19.0±3.2 | p<0.001 |
| p value** | p=0.368 | p=0.348 | |

Mean±standard deviation (mm Hg).
IOP; Intraocular Pressure, GAT; Goldmann Applanation Tonometer, ICT; iCare Tonometer.
*Paired t-tests were used to compare intraocular pressure (IOP) measurements between ICT sitting and supine position.
**Independent t-test were used to compare IOP measurements between PEX and control group.

***Table 2:*** *IOP values with GAT and ICT in pseudoexfoliation and control groups.*

| | GAT (mmHg) | ICT sitting (mmHg) | p value* |
|---|---|---|---|
| Pseudoexfoliation group (n=55) | 16.6±3.1 | 16.2±3.4 | p=0.055 |
| Control group (n=49) | 17.1±2.7 | 16.7±2.9 | p=0.207 |

Mean±standard deviation (mm Hg).
IOP; Intraocular Pressure, GAT; Goldmann Applanation Tonometer, ICT; iCare Tonometer.
*Paired t-tests.

Malihi et al.,[6] researched the effect of body and head position on IOP in 24 volunteers. They showed that in the case of extension or flexion of the head, supine, right or left lateral decubitus positions of the body, IOP measurements are 2.5 mmHg higher than sitting position and the difference was significant. We noticed mean 2.25 mmHg rise in supine position in our control group. This increase of IOP related to body position was statistically significant in our study (p<0.001 in PXS group, p<0.001 in control group).

Leonardo et al.,[28] showed that IOP rise in horizontal position in ocular hypertension group is higher than normal individuals. By using the Triggerfish 24-hour contact lens sensor, Lee et al.,[29] demonstrated that the IOP increases during supine position in normal tension glaucoma patients. Jain et al.,[8] showed that IOP rise in glaucomatous group is higher than nonglaucomatous group in sitting position (4.1 mmHg in glaucomatous group, 2.7 mmHg in nonglaucomatous group). Similarly Krieglstein et al.,[9] determined 3.9 mmHg IOP rise in glaucomatous group, 2.9 mmHg IOP rise in nonglaucomatous group in supine position. Tsukahara et al.,10 showed that mean IOP rise in supine position was 8.6 mmHg in normotensive glaucoma group; 6.5 mmHg in primary open angle glaucoma (POAG) group and 5.6 mmHg in control group. We noticed that mean IOP rise in PXS group was higher than normal population in our study (3.65 mmHg in PXS group, 2.25 mmHg in normal group). The higher results from Tsukahara et al might be caused by that they use Alcon pneumatonometer.

Ozkok et al.,[30] showed a higher increase in IOP in pseudoexfoliative glaucoma (PXG) patients from sitting to the supine position than in POAG patients in their study when they researched the IOP change in PXG and POAG patients between sitting and supine position. We compared PXS and normal individuals at the same age in respect to IOP change from sitting to supine position and observed that existence of pseudoexfoliation caused significant IOP rise in supine position. This difference may be due to the greater mobility of the lens and more fluctuation of IOP in PXS.

Ermis et al.,[31] evaluated IOP change and anterior chamber depth of PXS eyes in supine and prone positions. They reported that anterior chamber depth was decreased significantly in prone position, but IOP difference between supine and prone position was not significant. However they didn't study the difference between sitting and prone or supine positions on IOP.

In summary, IOP rised significantly in supine position in PXS eyes. Further studies on eyes with pseudoexfoliative glaucoma may help to show us the correlation between positional IOP rise with the severity of progression. IOP measurement with ICT is reliable and practical for all body positions, so that it can be used confidently for scanning and following up glaucoma in all age groups.

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