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Difference in Intraocular Pressure between Sitting Versus Supine Positions in Healthy and Glaucomatous Children by Rebound tonometery

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ABSTRACT

Background: Glaucoma's biggest treatable risk factor is elevated intraocular pressure (IOP) .Many factors have an impact on IOP, including body posture. Due to its convenience, lack of requirement for topical anaesthetic, and repeatable results, rebound tonometry has been claimed to be equivalent to the Goldmann applanation tonometer (GAT).
Aim of The Work: To study the effect of body posture (supine position versus sitting position) on the intraocular pressure (IOP) measurements in normal healthy children and glaucomatous children by using a Rebound tonometry.
Patients and Methods: The study was carried out on 80 children, divided into 20 cases of children with glaucoma, and 60 children with normal healthy eyes as control, all children attending the outpatient pediatric ophthalmology clinics, of Memorial Institute Kids Eye Center, Giza, Egypt between December 2020 and August 2021.
Results: With reference to IOP measurement among children, we found significant increase in IOP in supine position than in sitting position in both glaucomatous children and control groups. However, that increase in IOP were higher among glaucomatous children than healthy control group. However, there was no significant relation between gender, age of glaucomatous children and glaucoma treatment modalities with IOP measurement on sitting or supine position.
Conclusion: iCare PRO tonometer is a good, safe and reliable method for IOP measurement in children at age range from 4-12 years in both sitting and supine position. IOP is significantly increased in supine positions compared to sitting positions in healthy children, and more significant in children with glaucoma.

Keywords: *Intraocular pressure; Glaucomatous Children; Rebound tonometery.*

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INTRODUCTION

Glaucoma can occur alone or in conjunction with other ocular or systemic illnesses that affect both adults and children. [1] The measurement of intraocular pressure (IOP) is an important aspect of a standard eye checkup, especially for glaucoma patients. Indeed, in many circumstances, the major risk factor that physicians can change is increased IOP. [2]

Because it is often difficult to evaluate visual fields with minor changes in optic disc morphologic features that occur in young children, the importance of the patient's IOP was to aid in diagnosis, estimate the prognosis of glaucoma, and determine the efficiency of glaucoma treatment.[3]

IOP is dynamic and can be influenced by a variety of factors, one of the most important of which has been proven in earlier studies: variations in body position. [4] Furthermore, some investigations have shown that the difference between IOP values obtained in the supine and seated positions in adults varies greatly. In research comparing healthy people and glaucoma patients, the discrepancy ranges from 0.3 to 5.6 millimetres of mercury. [5] In adults, intraocular pressure (IOP) is commonly measured in a sitting position, but in pediatric age group, it is commonly measured in a supine position under general anesthesia .[6] Although, there are many studies that already studied the effect of general anesthesia on the intraocular pressure (IOP), but there is no clear information or confirmed study to clarify the effect of supine position only on the intraocular pressure (IOP) among pediatric age group. Nowadays, it has become possible to measure IOP in a sitting and supine positions among pediatric age group without general anesthesia, but there is no clear information if there is a change in the intraocular pressure between the sitting versus supine positions in young patients.[7]

GAT devices are available in the form of handheld battery-powered tonometers (e.g., Perkins) that may be utilised with a patient in a supine position. However, they have the disadvantage of requiring anaesthesia, fluorescein staining, and contact with the cornea.

* Noncontact air-puff tonometry works on the same premise as GAT, except it flattens the cornea using a puff of air. Noncontact airpuff tonometry is less reliable with higher IOP measurements, despite the fact that it does not require topical anaesthetic. [8]

The Tono-Pen is a portable tonometer that combines the qualities of applanation and indentation tonometry. It does, however, require topical anaesthetic and the tip of the instrument is cumbersome for a youngster.[1]

In the measurement of IOP in young children, the iCare tonometer appears to be the most useful tool. [9] According to the American Academy of Ophthalmology's recent Ophthalmic Technology Assessment, rebound tonometry was a reasonably accurate instrument that avoided the requirement for general anaesthesia in many children. , also, it can measure IOP in both supine and sitting position.[10]

The aim of this work was to study the effect of body posture (supine position versus sitting position) on the intraocular pressure (IOP) measurements in normal healthy children and glaucomatous children by using a Rebound tonometry.

PATIENTS AND METHODS

This is a cross-sectional observational clinical study that was carried out on 80 children, divided into 20 cases of children with glaucoma, and 60 children with normal healthy eyes as control, all children attending the outpatient pediatric ophthalmology clinic of (Kids eye center of memorial institute of ophthalmic research), between December 2020 and August 2021.

Inclusion criteria: Children of both genders, children of age between (4-12) years, normal anterior segment, and glaucomatous or suspected glaucomatous child.

Exclusion criteria: Contact lens wearer, children with history of corneal abnormality, children with history of ocular trauma or ocular surgery other than glaucoma surgery, children with history of ocular inflammation or retinal detachment, children with history of any physical, or mental problem, children using steroid as topical or systemic medications, and uncooperative child.

Informed consent: All children’s guardians were informed about the nature of the study and the details of the procedure and asked to provide written consent.

All children were subjected to the following:

Complete history taking include: Personal history as name, age, gender, and race. Ocular history: as previous history of trauma, and other ocular surgeries, onset, course, and duration of glaucoma. Medical history of current and previous medications the patient had been taken including systemic and topical steroids, anti-glaucoma medications, and past history.

Examination (Pre-test evaluation): General examination: to exclude any systemic conditions that are usually associated with rising of IOP as, hypertension, obesity, and ocular examination all studied subjects were examined using Hand held Slit Lamp examination or binocular indirect Ophthalmoscope to exclude any abnormality or ocular surface disease that may lead to change in IOP.

Several studies showed that IOP in normal healthy children ranged from 10 to 28 mm Hg, with Mean IOP 17.6 ± 2.7 mm Hg.[1, 11, 12] So, in our study, 35 healthy subjects by examination who presented with a mean IOP over 21mmHg in at least one eye were referred to the pediatric glaucoma clinic for further assessment, from those 35 subjects, 22 subjects were confirmed that no pathology or abnormalities were present so data from these subjects were included in the normal group ,13 subjects diagnosed as glaucoma and scheduled for medical , surgical or both and included in the glaucoma group .

Test protocols:

All children were not allowed to drink any liquids immediately an hour before the first measurement. During measurements, To prevent acts that may raise pressure on the eyelids or globe, youngsters were urged to relax (e.g. lid squeeze). A single experienced researcher took IOP measurements with an Icare PRO rebound tonometer (Icare; Tiolat Oy, Helsinki, Finland), which can be used in both the sitting and supine positions. . When the children arrived at the outpatient clinic for assessment, IOP measurements were taken between 9:00 and 11:30 a.m.

All children were seated for 10 minutes, The children were then instructed to look straight ahead to a distant point while the examiner brought the tonometer close to their eyes. After the tonometer was appropriately positioned, six serial IOP measurements were collected from their eyes in rapid succession while they remained in a sitting position. The patients were placed in a supine position on the clinic stretcher for the following 10 minutes, with no pillow. before having their IOP measured again. A new probe was used for each child.

Icare PRO tonometer has an automatic system The highest and lowest measurements are removed, and the remaining four readings are averaged. The reliability indicator, which reflects the standard deviation of individual IOP measurements, is next calculated. According to the color-coded measurement reliability technique of the Icare PRO tonometer, green signifies the lowest variability and best reliability, yellow indicates moderate fluctuation and dependability, and red indicates high variability and low reliability. For statistical analysis, only green average values were used. , indicating low variability and good reliability.

Statistical analysis:

The data was processed using the SPSS software programme for Windows version 23.0 (Chicago, IL, USA). For categorical data, the children's characteristics were tallied using number and percent, and for continuous variables, mean, range, and standard deviation (SD). The chi-square test was used to compare mean values of continuous variables and the Student t test was used to examine categorical variable distributions. The paired t test was used to complete comparisons between groups for continuous variables. A 0.05 p-value was utilised in all statistical tests.

RESULTS

	Cases (20)	Control (60)	P. value
	(Range) Mean ± SD		
Age (Years)	(6-12) 9.35 ± 1.69	(4-12) 8.03 ± 2.02	0.091
Gender:	N (%)	N (%)	
Male	9 (45)	28 (46.7)	
Female	11 (55)	32 (53.3)	0.553

Table 1: Comparison between cases and control groups as regard children age and gender.

The study was carried out on 80 children (their age ranged from 4-12 years), divided into 20 cases of children with glaucoma, and 60 children with normal healthy eyes as control. The age of glaucomatous children ranged from 6-12 years with a mean of 9.35 ± 1.69 years, with no significant difference between case and control groups (P = 0.091). As regard gender, the majority of glaucomatous children, 11 (55%) were females and 9 (45%) were males, with no significant difference between case and control groups (P = 0.553) (Table 1).

	Sitting position	Supine position	Difference	P. value[1]
	(Range) Mean ± SD			
IOP Cases				
Right eye	(19.2-32) 27.97 ± 3.95	(24.2-38.1) 32.83 ± 3.86	4.86	0.001*
Left eye	(22-32.6) 28.25 ± 3.43	(26.8-38) 33.03 ± 3.78	4.78	0.002*
P. value [2]	0.809	0.873		
IOP Control				
Right eye	(8.7-23.6) 18.27 ± 3.26	(9.2-33) 21.76 ± 3.75	3.49	0.007*
Left eye	(8.9-23) 18.80 ± 3.46	(12.7-26.5) 22.35 ± 3.18	3.58	0.008*
P. value [2]	0.898	0.911		

Table 2: Change in IOP among case and control group during sitting and supine positions.

With reference to IOP measurement among case group (glaucomatous patients) , there was significant increase in IOP measurement on supine position when compared with values obtained in sitting position in right eye as well as left eye (P1 = 0.001, 0.002 respectively). Moreover, there was no significant difference between right and left eyes in both positions (P2 = 0.809, 0.873 respectively). The mean difference in IOP measurement between supine and sitting positions was 4.86 mmHg in right eye, and 4.78 in left eye. With reference to IOP measurement among control group (healthy children), there was significant increase in IOP measurement on supine position when compared with values obtained in sitting position in right eye as well as left eye (P1 = 0.007, 0.008 respectively). Moreover, there was no significant difference between right and left eyes in both positions (P2 = 0.898, 0.911 respectively). The mean difference in IOP measurement between supine and sitting positions was 3.49 mmHg in right eye, and 3.58 in left eye (Table 2).

IOP	Age	
	r	p-value
Sitting position	-0.097	0.551
Supine position	-0.170	0.294

Table 3: Correlation between IOP and age of glaucomatous children.

There was no significant correlation between IOP measurement and age of glaucomatous children (P = 0.551, 0.294), as shown in (Table 3).

Gender	Sitting position	Supine position	Difference	P. value
	(Range) Mean ± SD			
Male	(21.2-32.6) 29.05 ± 3.7	(26.8-38.1) 34.27 ± 3.57	5.22	
Female	(19.2-32) 27.34 ± 3.51	(24.2-37) 31.83 ± 3.64	4.49	0.145

Table 4: Relation between IOP and gender of glaucomatous children.

With reference to IOP measurement among glaucomatous children, there was no significant relation between gender and IOP measurement on sitting or supine position (P = 0.145). The mean difference in IOP measurement between supine and sitting positions was 5.22 mmHg in male patients, and 4.49 in female patients, as shown in (Table 4).

Glaucoma treatment	Sitting position	Supine position	Difference	P. value
	(Range) Mean ± SD			
Received medical treatment	(25.9-29.3) 27.60 ± 2.40	(30.6-33.2) 31.90 ± 1. 83	4.30	0.167
Scheduled for medical treatment	(26.2-30.5) 28.30 ± 1.22	(29.1-36.4) 33.10 ± 2.33	4.80	
Underwent surgery	(19.2-26.6) 22.57 ± 2.50	(24.2-31.1) 27.75 ± 2.62	5.18	
Scheduled for surgery	(31-32) 31.57 ± 0.44	(34.2-38.1) 36.51 ± 1.20	4.94	
Received medical treatment and scheduled for surgery	(29.6-32.6) 31.02 ± 1.41	(33.9-36.8) 34.97 ± 1.30	3.95	
Scheduled for surgery plus medical treatment	(29.9-32) 31.37 ± 0.98	(34.2-38) 36.80 ± 1.79	5.43	

Table 5: Relation between IOP and glaucoma treatment of glaucomatous children.

With reference to IOP measurement among glaucomatous children, there was no significant relation between glaucoma treatment modalities and IOP measurement on sitting or supine position (P = 0.167). The mean difference in IOP measurement between supine and sitting positions was 4.30 mmHg in patients received medical treatment, 4.80 mmHg in patients scheduled for medical treatment, 5.18 mmHg in patients underwent surgery, 4.94 mmHg in patients scheduled for surgery, 3.95 mmHg in patients received medical treatment and scheduled for surgery, and 5.43 mmHg in patients scheduled for surgery plus medical treatment as shown in (Table 5).

	Sitting position	Supine position	Difference	P. value[1]
	(Range) Mean ± SD			
Case	(19.2-32.6) 28.16 ± 3.65	(24.2-38.1) 33.19 ± 3.68	5.03	0.001*
Control	(8.7-23.6) 18.87 ± 3.36	(9.2-33) 22.05 ± 3.50	3.27	0.001*
P. value [2]	0.001*	0.001*	0.021*	

Table 6: Comparison between cases and control groups as regard change in IOP during sitting and supine positions.

There was highly significant increase in IOP among glaucomatous children than healthy control (P1 = 0.001), as well, there was highly significant increase in IOP during supine position than sitting position in both groups (P2 = 0.001). The mean difference in IOP measurement between supine and sitting positions was 5.03 mmHg in glaucomatous children, and 3.27 in healthy control, as shown in (Table 6).

DISCUSSION

The difference between sitting and supine position has been studied before but mainly in adult.[13, 14, 15, 16] So, this analysis aimed to study the effect of body posture (supine position versus sitting position) on IOP measurements in normal healthy children and glaucomatous children by using a Rebound tonometry.

This study was carried out on 80 children (20 cases of children with glaucoma, and 60 children with normal healthy eyes as control). In our study, we found no significant difference between case and control groups as regard age and gender. In accordance to our findings, Mostafa et al.[13] conducted a prospective study on 90 subjects with 180 eyes. The subjects were separated into three groups (normal, glaucoma suspicion, and primary open angle glaucoma), and it was discovered that there were no statistically significant variations between the groups when age and gender were compared.

In the present pediatric study, we found significant increase in IOP in supine position than in sitting position in both glaucomatous children and control groups. However, that increase in IOP were higher among glaucomatous children (increased by 4.8 mmHg) than healthy control group (increased by 3.5 mmHg).

To the best of our knowledge, most previous studies were conducted in adults. However, Dosunmu et al.[17] conducted a prospective pediatric study on 47 children (94 eyes) Those who have glaucoma or are suspected of having glaucoma, as well as those who do not have glaucoma. The Icare PRO or the Tono-Pen were used to perform tonometry in both eyes while the subjects were upright (seated), and then the second instrument was used (order randomized). After 5 minutes in the supine position, the patients were given tonometry using the Icare PRO and the Tono-Pen, in the same order as when they were in the sitting position. They discovered a tiny (1mmHg) but statistically significant increase in IOP with the change in a child's position from sitting to supine at the end of the research. With both the Icare PRO and the Tono-Pen equipment, the IOP increase was quantifiable and of comparable magnitude.

Although, the previous finding goes in line with ours, but they studied children above 12 years old and we studied children below 12 years old, furthermore, they used topical anesthesia before IOP measurements as it is needed for tonopen measurments, but we didn't use topical anesthesia, in addition, they found significant increase in IOP in supine position than in sitting position with than 1 mmHg, and we found significant increase in IOP in supine position than in sitting position with 4.8 mmHg.

As regard non-pediatric studies, the study conducted by Mostafa et al.[13] they reported that, there was a statistically significant increase of IOP in supine positions compared to sitting positions in all study groups.

Also, Hirooka et al.[18] They reported that the averaged IOP difference between the sitting and supine positions was 4.11.6mm Hg in a prospective, nonrandomized investigation on 10 eyes of 10 patients with primary open-angle glaucoma and 3 eyes of 3 patients with normal-tension glaucoma. Other previous research When compared to measurements taken in the sitting position, 14, 15, 16, also shows an increase in IOP when in the supine position.

The previous findings could be explained by the fact that changes in IOP caused by posture are caused by choroidal vascular congestion. Increased episcleral venous pressure and increased episcleral venous pressure could be caused by factors other than aqueous production. 5 IOP increases when changing from a sitting to a supine or lateral decubitus position because to hydrostatic factors, increased episcleral venous pressure, or changes in uveoscleral outflow rate.16

Friberg et al.[19] Mechanical compression of the orbit and higher orbital venous pressure resulting from the absence of venous valves in the orbits have been reported as reasons of elevated IOP in recumbent/ inverted situations. Moreover, these IOP changes have been associated with an increase in nocturnal IOP and could be related to the progression of glaucoma.[20]

In contrast to our results, Nakakura et al.[21], conducted a recent prospective cross-sectional study They used GAT, IcarePRO, and IC200 on 145 eyes of 145 glaucoma patients in the sitting and supine positions, and found no significant variations in IOP values between the sitting (13.3 mmHg) and supine positions (14.5 mmHg) for Icare PRO rebound tonometer, with difference (1.2 mmHg).

Uzlu et al. [22], conducted a study on 49 eyes of 49 healthy children. Patients' IOP was assessed using an ICARE rebound tonometer in standing, sitting, and supine positions. They concluded that there were no statistically significant differences in pairwise comparisons of the measurements taken in the various positions at the end of the study.

This variation between the previous studies and ours may be due to different sample size, ethnicity, whether or not the patient had undergone filtering surgery, whether they were healthy or had glaucoma, and variances in ocular biomechanical traits were all factors considered. and the influence of topical anaesthetic on the measured IOP were all factors.

In this study, we found no significant correlation between IOP measurement and age of glaucomatous children, as well as, no significant relation between IOP measurement and gender of glaucomatous children. This goes in line with, Mayal et al.[4] who demonstrated that, Gender and age had no bearing on IOP in various body postures.

As regard relation between IOP and glaucoma treatment in the present study, we found that, although IOP measurement were smaller, the difference in IOP between sitting and supine position was much higher among patients underwent glaucoma surgery (5.18 mmHg).

In continuation with our findings, Weizer et al.[23] The IOP change caused by position was much smaller in the trabeculectomized eyes than in the contralateral eyes that were not operated (4.6 mmHg versus 6.1 mmHg).

Moreover, Parsley et al.[24] IOP was measured in standing, sitting, and supine positions in the non-operated, medically treated chronic OAG eyes and the control eyes. Moving from a sitting to a supine posture elevated IOP by 5.49 mmHg in the operated eyes and 4.02 mmHg in the nonoperated OAG eyes, according to the researchers, while the control eyes increased by 0.9 mmHg.

The previous findings may be explained by the fact that, glaucoma surgery yields a newly aqueous pathway independent of the episcleral veins leading to significant decrease in IOP. However, after filtering surgery, there was still a considerable IOP difference between the sitting and supine positions, demonstrating that glaucoma treatment does not totally eliminate postural IOP changes. [25]

CONCLUSION

iCare PRO tonometer is a good, safe and reliable method for IOP measurement in children at age range Between the ages of 4 and 12, in both a seated and a supine posture. Furthermore, in healthy children, IOP is much higher in supine postures compared to sitting positions, and this difference is even greater in children with glaucoma. Gender and age showed no effect on IOP when assessed in various body postures.

Conflict of interest : none

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