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Comparison of air puff tonometer with goldman applanation tonometer in different corneal thickness measurements

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To compare Air puff tonometer to Goldman Applanation tonometer in different corneal thickness measurements and to find out the corneal thickness for which Air Puff measurements are closely related to Goldman tonometer.Cross sectional comparative study. Ophthalmology department Madina Teaching hospital Faisalabad from February 2016 to August 2016.Study was comparative cross sectional, conducted in outpatient department of Madina Teaching Hospital Faisalabad, Pakistan. Total of 50 subjects i.e. 100 eyes were checked by random sampling procedure considering inclusion criterion, for intraocular pressure by both Air puff and Goldman Applanation tonometer, corneal thickness was checked with automated corneal topographer. In younger subjects of age 15-28years old patients were found of corneal thickness is of average category of value 478-533nm, Adult was assigned the name of subjects of age 29-42years and corneal thickness among this age was equal in number in moderate 478-533nm, and thick cornea 534-589nmgroups. Old was assign name of group of subjects among age 42-55years and corneal thickness among this age group was maximum in thick cornea group. IOP by Air Puff tonometer measured in thin cornea (422-477nm) was 16.88+-2.78, in moderate corneal thickness (478-533nm) was 15.99+_2.93 and in thick cornea(534-589nm) was 17.15+_3.09.while IOP measured by Goldmann in thin corneas 15.38-+_2.93 for moderate corneal 14.97+-3.18 for thick corneas 16.56+_2.83.There is insignificant relationship between age and central corneal thickness. Air puff overestimates intraocular pressure than Goldmann tonometer. Goldmann Applanation tonometer and air puff tonometer are comparable with minimum variation in moderate corneal thickness(478-

Keywords: Intraocular pressure, central corneal thickness, tonometr.

INTRODUCTION

The liquid called aqueous humour that applies pressure inside an eye is known as intraocular pressure (IOP). It is a critical analytic parameter to decide the condition of wellbeing of eye. In clinical practice tonometry test is done through the corneoscleral coat by various sorts of tonometer.(Ljubimova.2009)

Tonometry identified with eye is estimation of intraocular pressure. A tonometer is the instrument that uses the physical properties of the external layers of eye for the estimation of intraocular pressure without the need to embed tube into the eye.

a. An exact appraisal of IOP is key in building up conclusion of glaucoma and choice in regards to different treatment modalities available .Tonometry, or the estimation of IOP, the pressure of the liquid inside the eye is normally the main modifiable variable in administration of a wide range of glaucoma.(Shah et al.2012)

Corneal thickness is imperative since it can veil an exact measurement of eye pressure, making specialists treat you for a condition that may not by any stretch of the imagination exist or to treat you superfluously when unnecessary. Genuine IOP might be thought little of in patients with thinner CCT, and overestimated in patients with thicker CCT.

Ordinarily, patients with thinner corneas under 555 µm demonstrate misleadingly low intraocular tension readings. This is risky in light of the fact that if real intraocular tension is higher than measurement appears, It might be at danger for creating glaucoma and specialist may not know it. Left untreated, high intraocular tension can prompt glaucoma and vision misfortune. It is essential that specialist have an exact intraocular tension perusing to analyze danger and choose a treatment arrangement (Drake.2011)

The quantitative appraisal of intraocular pressure is known as tonometry; and the instruments utilized for tonometry are known as tonometer. Every method has intrinsic focal points and weaknesses, none is

perfect.(Stamper.2011)

Goldmann applanation tonometer - It depends on Imbertficks law which says that for perfect circle (superbly circular, dry, boundlessly thin walled and splendidly adaptable) the tension inside the circle is equivalent to compel required to straighten/applanate the surface isolated by the zone of leveling.

Non-contact tonometer: Introduced by Grolman in 1972, in air puff tonometry, the applanating power is a segment of air which is discharged with progressively expanding force. At the purpose of corneal smoothing, the air section is stopped and the power right then and there is recorded and changed over to mm Hg. The readings associate well with Goldman Applanation tonometer.(Singh.2014)

Non-contact tonometer is seen to be reliable in the normal range of IOP as compared to Goldmann tonometer because its reading is affected by abnormal cornea.(Paul.2006)

Up till now comparison of two instruments on different corneal thickness in not done in Pakistani Population.This study aimed to estimate differences of measurements by two instruments and relate the measured value of Air puff Tonometer with Gold standard Goldman's Applanation tonometer in particular corneal thickness and find the particular thickness and find the particular thickness at which Air puff is nearest to Goldmann measurement so that at that thickness values air puff can be used instead of Goldmann tonometer.

MATERIALS AND METHODS

This study was Cross sectional comparative study. Central corneal thickness and Intraocular pressure measurements were taken from patients visiting eye out patient department Madina Teaching Hospital Faisalabad. 50 patients were checked for corneal thickness and intraocular pressure measurement for both eyes i.e right and left. 100 eyes used to take measurements.

Patients with refractive error within ±2D spherical.Only those patients were selected having normal fundus on direct ophthalmoscope examination and normal corneal thickness and healthy cornea.AllPatients having refractive error >±2D,Any active eye diseases e.g uveitis, corneal disease, infection, discharge, Patients with age- related macular degeneration, Astigmatism and keratoconus and post refractive surgery were excluded from the study.Intraocular pressure measurements were taken by the two instruments i.e. Air puff tonometer and Goldman tonometer. Central corneal thickness were measured by ultrasound topographer.

Measurements were taken by this order:

1. Central corneal thickness
2. IOP measurements by Air puff
3. IOP measurement by Godlmann

Interval of recordings by the two instruments were minimum of 5 minutes.Airpuff tonometry is done first as Goldman tonometry can affect corneal properties and error can be induced in Air Puff recording.

RESULTS

Total 100 subject were included in the study they were divided in to three main groups according to age. Out of 100, 62 subjects were fall in the category of young age i.e between 15-28years, total percent of young were 62%.In the category of adult subjects were 24 so 24%.old age were 14 and 14% of total sample so young group was more in this study. Out of which males were 71 and female 29.

1-3 cells (33.3%) have expected count less than 5. The minimum expected count is .56.

In group of moderate corneal thickness(478-533nm)out of total 47 only 4 subjects were found in the category of slightly higher pressure(19.7-22.5mmHg), 8 in group normal pressure(16.8-19.6mmhg),17 in average pressure(13.9-16.7mmhg) and 18 in low pressure(11-13.8mmhg) category.

In group of thick corneas (534-589nm) out of total 49 subjects 19 were in the category of low pressure, 16 were in the category of average pressure,19 in normal pressure,3 slightly higher and 2 were found in the category of high pressure

IOP Air puff in CCT.

In group of thin cornea(422-477nm) out of total 4 only 2 subject fall in category of average corneal thickness(13.6-16.1) and 2 in category of slightly higher pressure(19.7-22.5mmHg).

In group of moderate corneal thickness(478-533nm)out of total 47 only 7 subjects were found in the category of slightly higher pressure(19.7-22.5mmHg), 14 in group normal pressure(16.8-19.6mmhg),13 in average pressure(13.9-16.7mmhg) and 11 in low pressure(11-13.8mmhg) category.

In group of thick corneas (534-589nm) out of total 49 subjects 6 were in the category of low pressure,8were in the category of average pressure,14 in normal pressure,7 slightly higher and 2 were found in the category of high pressure.

IOP Air puff in CCT.

In group of thin cornea(422-477nm) out of total 4 only 2 subject fall in category of average corneal thickness(13.6-16.1) and 2 in category of slightly higher pressure(19.7-22.5mmHg).

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In group of thick corneas (534-589nm) out of total 49 subjects 6 were in the category of low pressure,8were in the category of average pressure,14 in normal pressure,7

slightly higher and 2 were found in the category of high pressure. That variation in measurement of intraocular pressure between the two instrument is inversely proportional to corneal thickness .Variation of measurements between goldman and applanation tonometers is maximum in thin corneas and it gradually decreases as the thickness of cornea increases. Variation is minimum in thick corneas and percentage of variation is 42.6% while percentage of variation in thin corneas is 60.9% which is maximum.

In this study it is assessed that age the age increases corneal thickness increases

			Central corneal thickness			Total
			thin cornea 422-477	moderate thickness-478-533	thick cornea-534-589	
age	15-28(young)	Count	2	33	27	62
		% within central corneal thickness	50.0%	70.2%	55.1%	62.0%
	29-42(adult)	Count	2	11	11	24
		% within central corneal thickness	50.0%	23.4%	22.4%	24.0%
	42-55(old)	Count	0	3	11	14
		% within centralcornealthickness	0.0%	6.4%	22.4%	14.0%
Total		Count	4	47	49	100
		% within centralcornealthickness	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.169[a]	4	.127
Likelihood Ratio	7.569	4	.109
Linear-by-Linear Association	3.297	1	.069
N of Valid Cases	100		

IOP Goldman * central corneal thickness Cross tabulation					
Count					
		Central corneal thickness			Total
		thin cornea 422-477	moderate thickness -478-533	thick cornea-534-589	
IOP Goldman	11-13.8(low)	1	18	9	28
	13.9-16.7(average)	0	17	16	33
	16.8-19.6(normal)	3	8	19	30
	19.7-22.5(slightly higher)	0	4	3	7
	22.6-25.4(high)	0	0	2	2
Total		4	47	49	100

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	14.047[a]	8	.081
Likelihood Ratio	16.033	8	.042
Linear-by-Linear Association	3.110	1	.078
N of Valid Cases	100		
a. 9 cells (60.0%) have expected count less than 5. The minimum expected count is .08.			

IOP Air puff * central corneal thickness Cross tabulation					
Count					
		Central corneal thickness			Total
		thin cornea 422-477	moderate thickness-478-533	thick cornea-534-589	
IOP Air puff	11-13.5(low)	0	11	6	17
	13.6-16.1(average)	2	13	8	23
	16.2-18.7(normal)	0	14	20	34
	18.8-21.3(slightly higher)	2	7	12	21
	21.4-23.9(high)	0	2	3	5
Total		4	47	49	100

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.497[a]	8	.232
Likelihood Ratio	12.040	8	.149
Linear-by-Linear Association	2.271	1	.132
N of Valid Cases	100		
a. 7 cells (46.7%) have expected count less than 5. The minimum expected count is .20.			

	n	IOP Goldman and Air puff Correlation coefficient	IOP Average of Goldman (mean±Sd) (mmHg)	IOP Average of Air Puff (mean±Sd)(mmHg)	Differences between IOP Goldman and Air Puff(mean±Sd)(mmHg)
Thin cornea	4	.577	15.38±2.93	16.88±2.78	1.5±0.15
Average cornea	47	.759**	14.97±3.18	15.99±2.83	1.02±0.35
Thick cornea	49	.731	16.56±2.83	17.15±3.09	0.59±0.26

Group	Price Related Differential	Coefficient of Dispersion	Coefficient of Variation
			Median Centered
thin cornea 422-477	1.050	.333	60.9%
moderate thickness-478-533	1.078	.329	55.5%
thick cornea-534-589	1.048	.297	42.6%
Overall	1.060	.313	49.2%

DISCUSSION

Non-contact tonometer is seen to be reliable in the normal range of IOP as compared to Goldmann tonometer because its reading is affected by abnormal cornea.(Paul.2006).

This study aimed to estimate differences of measurements by two instruments and relate the measured value of Air puff Tonometer with Gold standard Goldman's applanation tonometer in particular corneal thickness.

Many studies have been done to compare the measurements of intraocular pressure by different instruments and relate their measurements.

Javied Ahmad et al conducted study on Accuracy of IOP Measured by Non-Contact (Air – Puff) Tonometer Compared with Goldmann Applanation Tonometer. He found that the exactness of air puff tonometer was higher 54.40% in typical scope of IOP 10-20 mm Hg however the precision continuously diminished at higher values of IOP.In this study the air puff tonometer reliably overestimated IOP than Goldmannapplanation tonometer that was additionally appeared in other studies. Interestingly some studies have demonstrated that air puff tonomaters returned lower values in respect to goldmann tonometer.(Ahmad etal.2014)

A study done by Shalini Mohan et al.(2013) compared two tonometers Keeler's Pulsair NCT with Gold man tonometer in the population of India ,study recommend that Keeler's Pulsair tonometer is a reasonable tool for screening purposes as it can be easily employed by residents and health care personals but in higher intra ocular tension measurements instrument reliability decreases. The mean of the paired difference in IOP was lesser in IOP less than 18 than above that. These differences in IOP were more common at the higher IOP ranges than the IOP in lower teens. Analysis revealed that pulsair measure reliable if intra ocular tension is within normal range i.e below 18mmhg.theses observation relates well with other studies also. Theses observation shows that NCT has shortcoming of reliability at higher intraocular pressure measurements and more reliable and

correlates well with Goldman in 15mmhg pressure range.(Mohan et al.2013)

There is little difference between the relationship of comparison of two Goldmann readings and the correlation of Pulsair against the Goldmann.with practice, the Pulsair can give an exact estimation of IOP inside around 20 seconds for every eye and destroys most administrator impacts or error. It has likewise been utilized on numerous events as a part of our center to test the IOP of infants and kids keeping away from the requirement for general anesthesia. All in all, the Pulsair 3000 is as exact as Goldmann tonometry in the populace considered and has unmistakable favorable circumstances.(Parker et al.2001)

Patikulsila et al did Comparison of intraocular tension measured by non-contact air puff versus Goldman applanation tonometers in gas-filled vitrectomized eyes and found that applanation Tonometer associate well with Goldman applanation tonometer yet , in eyes with raised IOP, the APT altogether be littled the IOP estimation when compared with the best quality level, GAT.(Patikulsila et al.2003).

Schreiber et al did correlation on the theme of an examination of bounce back tonometry (ICare) with TonoPenXL and Goldman applanation tonometry and found that The ICare tonometer is anything but difficult to handle and high unwavering quality. The information are practically identical with those from the Goldman tonometer. A tonography impact of 0.6 mmHg in the progressive estimation arrangement was found.(Schreiber et al.2007).

Brencher et al considered Clinical examination of air-puff and Goldman tonometers and presumed that for eyes with tension in the 10-20 mmHg range, the CT-10 read reliably too high. The XPERT and the NCT II read too high in the lower some portion of this extent and too low in the higher part. The PULSAIR read too low over the whole range. At higher weights, the greater part of the tonometers read too high with the exception of the PULSAIR which again read too low. CT-10, XPERT, and NCT II and PULSAIR tensions were inside 4.0 mmHg of Goldman readings for 81, 85, 89 and 72 percent of the eyes, separately. Subjects chose the XPERT as the most favored tonometer and the NCT II was the minimum favored chiefly on account of saw air-puff force.(Brencher et al.1991).

Galgauskas.S et al analyzed the relationship between measurements of Goldmann tonometer (GAT), Tono-Pen and I-Care tonometer in young healthy adults and investigated the effect of corneal thickness (CCT) on intraocular tension measurements taken with tonometer specified. In this Investigation it was found that both Tono-Pen and I-Care tonometers measure intraocular tension higher than its value measured with the Goldman tonometer values. Instruments comparison showed that both the Tono-Pen or I-Care tonometers measurements results were similar to Goldman so these can be used in the place of Goldman tonometer however Higher corneal thickness values more than 555 µm were found to be associated with overestimated intra ocular tension values.(Galgauskas et al.2016)

Dora H et al. (2016) compared intraocular tension measurements by two different categories i.e rebound in children with glaucoma in sedative supine position. Study shows that there is difference of measurement s by different type of instrument i.e Icare PRO underestimate tension of eye from Pneumo tonometer and Tono-Pen XL**.**(Dora et al.2016)

Kingsley C et al. studied Goldmann applanation tonometry (GAT) is 50-year-old innovation, and found that there is no flawless tonometer, and clinicians must pick which to use in their day by day work on, adjusting exactness, accuracy, accommodation, and expense. Clinicians ought to perceive that a solitary IOP estimation is yet a regularly mistake inclined depiction of a broadly fluctuating physiologic parameter. IOP information ought to just be utilized as a part of the setting of the general clinical picture.(Kingsley et al.2015)

Kato K. compared two instruments with same principal (i.eapplanation tonometry) of measurement of intraocular pressure.name of instruments used were (Tono-Pen XL(®) and AccuPen, The Tono-Pen XL measurements were minimal but significantly higher than the AccuPen(®) measurements in both diseased canine and normal eyes. The CCT have no effect on the measurements of both types of instrument.(Kato.2014)

Whitacre MM and Stein R found in their study that many sources of error exist in the use of Applanation tonometer like Goldmann tonometer. Large tonometric error can be due the following factors like accommodation, the Valsalva maneuver and vertical gaze, hypofluorescence of clinically normal corneas the precorneal tear film. Results of the study correlates with the fact that readings with Goldman tonometer can be reliable clinically but not absolute and comparable manometric measurements. (whitacare and stein.1993).

Patel KJ et al studied on reliability of instruments for the measurement of intra ocular tension by comparing and taking measurements from each of the instruments, categories of instruments assessed were Applanation (Goldmann), noncontact and dynamic contour tonometer.as for treatment of glaucoma accurate measurement of intra-ocular tension is important. From this study it is concluded that for one patients with glaucoma one type of tonometer should be used for each visit.As variation in weather geographic conditions and effect on human body so corneal thickness also affects by these external factors (Parel et al.2016)

Yilmaz.I et al. measured intraocular pressure by three different tonometers, tono-pen non-contact Airpuff and Goldmann applanation tonometer. It was concluded that only in eyes with normal tension gold man can be replace with tonopen XL and noncontact tonometer·(Yilmaz.2014)

Cook JA et al.(2012) surveyed the assention of tonometers accessible for clinical practice with the

Goldmann applanation tonometer (GAT), the most usually acknowledged reference gadget. The NCT and HAT appear to accomplish estimation nearest to the GAT. Be that as it may, there was considerable variability in estimations both inside and between studies.(Cook et al.2012).

CONCLUSION

The study was set out to compare the readings of Air puff tonometer with Gold standard Gold man tonometer in corneal thickness measurements. Results reported in this study shows that as age of human increases central corneal thickness Goldman applanation tonometer and air puff tonometer are comparable with minimum variation. Air puff tonometry is also increases. It is found in this study that there is more variation between measurements of instruments in thin corneas this variation decreases as the thickness of cornea increases so measurements by most reliable and comparable to gold standard Goldman tonometres only in corneas with thickness value above 534nm.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

Dr.Rubina Kousar (manuscript concept,Designing and peer review).Dr.Rahat-ul-Ain (manuscript and data analysis).Dr.Tahira Kalsoom (statistical analysis, technically support)

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