International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

A Comparative Study of Intraocular Pressure Measurement Using Tonopen and Goldmann Applanation Tonometer

Dr. Rajesh R Nayak[1], Dr. Pooja Kandula[2], Dr. Bhavini Johri[3], Dr. Shobha G Pai[4], Dr. Sumana J Kamath[5]

[1]Associate Professor, Kasturba Medical College, Mangalore, Manipal University

[2]Postgraduate, Kasturba Medical College, Mangalore, Manipal University

[3]Undergraduate, Kasturba Medical College, Mangalore, Manipal University

[4]Head of the Department, Kasturba Medical College, Mangalore, Manipal University

[5]Professor, Kasturba Medical College, Mangalore, Manipal University

Abstract: ***Background: Glaucoma is the world's leading cause of preventable irreversible blindness. The most important risk factor of glaucoma is increase in the intraocular pressure.Hence, timely screening by accurate IOP measurements is of utmost importance. In recent years, Tonopen has emerged as an alternative to Goldmann applanation tonometer which is the 'gold standard' for IOP measurement because of its various advantages. Since its reliability has not yet been confirmed, this study aims to assess the accuracy of the Tonopen in measuring the IOP as compared to the Goldmann applanation tonometer. Objective: To determine whether Tonopen is accurate and reliable in measuring the intraocular pressure as compared to Goldmann applanation tonometer. Methodology: In this prospective cross-sectional study, 113 patients above 40 years coming for routine eye check-up and who were diagnosed earlier as glaucoma patients their IOP was measured. The Tonopen was used first followed by the Goldmann applanation tonometer. Collected data was analyzed using SPSS version 17.0. The results were expressed in terms of sensitivity, specificity, positive and negative predictive value and accuracy rate. Institutional Ethics Committee clearance was obtained prior to commencement of study. Results: For the right eye, the sensitivity of the Tonopen in detecting glaucoma was 60% and the specificity was 94.44%. The positive predictive value and the negative predictive value were 33.33%and 98.08% respectively. Percentage of false-negatives obtained were 40% and percentage of false-positives obtained were 5.55%. Accuracy rate of the Tonopen was 92.92%. For the left eye, sensitivity was 75% and specificity was 96.33%. The Positive predictive value and negative predictive value were42.86% and 99.06% respectively. Percentage of false-negatives obtained were 25% and percentage of false-positives were 3.67%. Accuracy rate of the Tonopen was 95.57%. Area under the Receiver Operating Characteristic curve was 0.887 with a standard error of 0.085 in case of the right eye. For the left eye, the area under the curve was 0.972 with a standard error of 0.027. Conclusion: According to this study, the Tonopen is an accurate and reliable indicator of Intraocular pressure.***

Keywords: Goldmann applanation, Tonopen, glaucoma

1. Introduction

Intraocular pressure is determined by the balance between the rate of aqueous production and its outflow which is in turn related to factors that include the resistance encountered in the trabeculum and the level of episcleral venous pressure. [1] An IOP between 10 and 21 mm Hg is considered to be statistically normal. [2].According to the statistics in 2010, Glaucoma is estimated to be affecting 60.5 million persons and responsible for vision loss among 8.4 million. The silver lining in the cloud is that the rate of visual deterioration can be reduced by lowering of intraocular pressure. Hence, timely screening for this disease can save many patients from turning blind. [3] As a result, accurate IOP measurements are of utmost importance and any discrepancies could lead to delay in the detection and treatment of this disease. [4]

For uncooperative patients or those who have irregular corneas, Tonopen may be considered as an alternative over Goldmann applanation tonometer.

The Tonopen is an automatic microprocessor controlled tonometer which is compact and portable. Also, it operates independent of patient position and is easy to calibrate and operate. Other advantages are that its tip has a disposable cover which helps to eliminate contamination risks and user bias is effectively minimized by the digital readout. [4, 5]

There is no substantial proof yet for the Tonopen being a reliable indicator of intraocular pressure, however certain studies suggest that Tonopen measures IOP accurately which could help overcome the limitations of the Goldmanntonometer [4]. Hence, the need of the hour is to conduct further investigations and carry out more research to arrive at a conclusion. Depending on the outcome, use of the Tonopen can be encouraged or discouraged in clinical practice.

2. Objective

To determine whether Tonopen is accurate and reliable in measuring the intraocular pressure as compared to Goldmann applanation tonometer.

3. Methodology

- **Study setting:** The study will be carried out in tertiary care hospital attached to the college.
- **Study design:** Prospective cross-sectional study
- **Study population:** Patients above 40 years of age coming for routine eye check-up and patients having glaucoma.
- **Sample size:** With 95% confidence level and 80% power with respect to a previous study, the sample size comes out to be 113. [6]

$$n = \frac{(Z\alpha)^2 S_N(1-S_N)}{l^2 p}$$

Zα = 1.96 at 95% confidence level
S_N (sensitivity) = 0.62
l = allowable error
p = prevalence.
n=113

Inclusion Criteria: Patients above 40 years coming for routine eye check-up and patients diagnosed as glaucoma.
Exclusion Criteria: Patients with corneal scarring, astigmatism above 3.5 diopters, previous corneal surgery and those who refuse to give their consent for the study.
Sample strategy: Convenient Sampling
Study duration: 1st June 2016 to 31st July 2016
Tool for data collection: Tonopen and Goldmann applanation tonometer

Data collection methodology: The study protocol will be submitted for approval from the Institutional Ethics Committee (IEC) of the college. After obtaining approval from IEC, permission will be obtained from the Head of the Institution and the Hospital Authorities.

The patients will be approached in the Ophthalmology Department of the study hospitals. The objectives of the study will be explained to them, following which an informed consent will be taken. Data collection will be done using a Tonopen and Goldmann applanation tonometer after anesthetizing patient's cornea with a drop of local anesthetic.

The tonopen will be used first. First anesthetizing the cornea with paracaine drops, under aseptic precautions it will be touched with the tonopen after covering the tip of the tonopen with disposable latex cover. Two readings will be taken and the final intraocular pressure will be an average of these values.

For using the Goldmann applanation tonometer, paracaine drops were used to anaesthetize the cornea, fluorescein dye is used to stain the tear film. Under the slit lamp illumination by cobalt blue light, thebiprism will be advanced onto the apex of the cornea and two fluorescent semicircles will be visualized. The end point is when the inner edges of the two semicircles meet, which is adjusted by turning the knob of the applanation tonometer. Then we multiply the value with 10 which is the final intraocular pressure.

Data analysis: Analysis will be done by estimating sensitivity, specificity, positive predictive value, negative predictive value and accuracy rate. The Statistical Package for Social Sciences (SPSS) version 17 will be used for entering data and analyzing it. $p < 0.05$ will be considered as significant.

4. Results

General Participant Information

Table 1: *Age group*

40-50 years	43(38.1%)
51-60 years	30(26.5%)
61-70 years	27(23.9%)
71-80 years	10(8.8%)
81-90 years	3(2.7%)

Table 2: Sex

Male	*57(61.9%)*
Female	*43(38.1%)*

Table 3: Presence of co-morbidities

Diabetes Mellitus	16(14.2%)
Hypertension	15(13.3%)

Table 4: Glaucoma

Presence of glaucoma in right eye	3(2.7%)
Presence of glaucoma in left eye	2(1.8%)
Presence in both eyes	2(1.8%)

Intraocular pressure measurements in right eye of 113 patients with Tonopen and Goldmann Applanation tonometer(Figure 1)

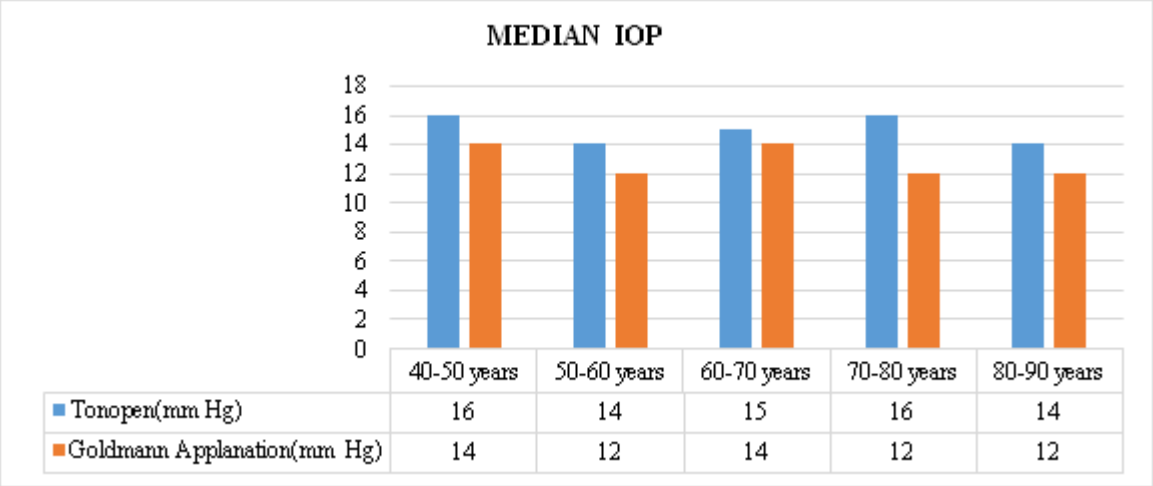

Figure 1

Intraocular pressure measurements in left eye of 113 patients with Tonopen and Goldmann Applanation tonometer (Figure 2)

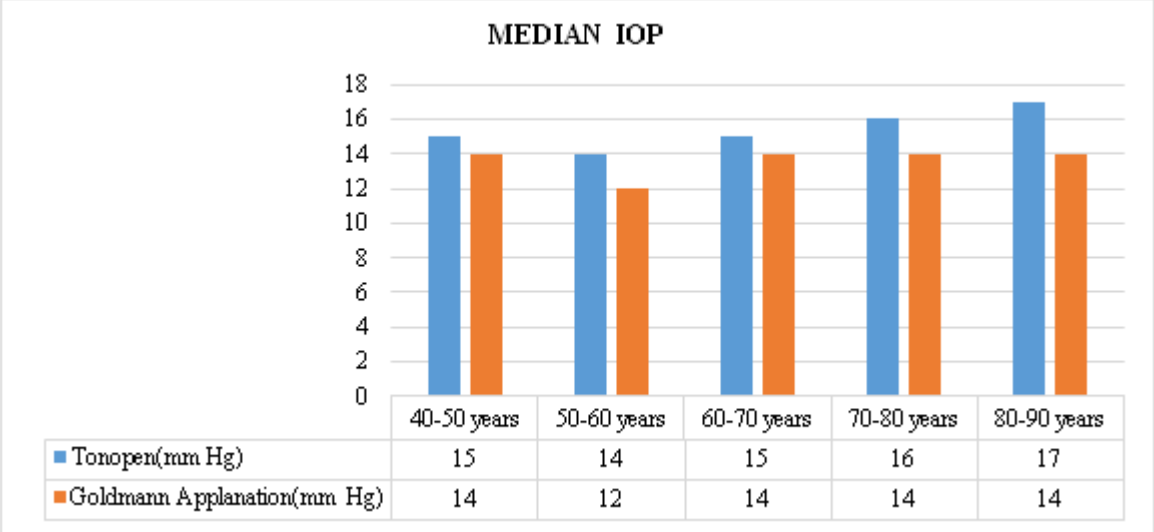

Figure 2

The sensitivity, specificity, positive predictive value, negative predictive value and accuracy rateof both the Tonometers were calculated using thefollowing tables.

Comparison of Tonopen and Goldmann Applanation Tonometer for the right eye. (Table 5)

GLAUCOMA

Tonopen test results	Present	Absent	Total
Positive	3	6	9
Negative	2	102	104
Total	5	108	113

The sensitivity obtained in the right eye was 60% and specificity was 94.44%. The positive predictive value was 33.33% and the negative predictive value was 98.08%. The percentage of false-negatives obtained were 40% and the percentage of false-positives obtained were 5.55%.The accuracy rate of the Tonopen was 92.92%.

Comparison of Tonopen and Goldmann Applanation Tonometer for the left eye. (Table 6)

GLAUCOMA

Tonopen test results	Present	Absent	Total
Positive	3	4	7
Negative	1	105	106
Total	4	109	113

The sensitivity obtained in the left eye was 75% and specificity was 96.33%. The positive predictive value was 42.86% and the negative predictive value was 99.06%. The percentage of false-negatives obtained were 25% and the percentage of false-positives were 3.67%. The accuracy rate of the Tonopen was 95.57%.

The Receiver Operating Characteristic curve was obtained for both the eyes as shown below.(Figure 3 and 4)

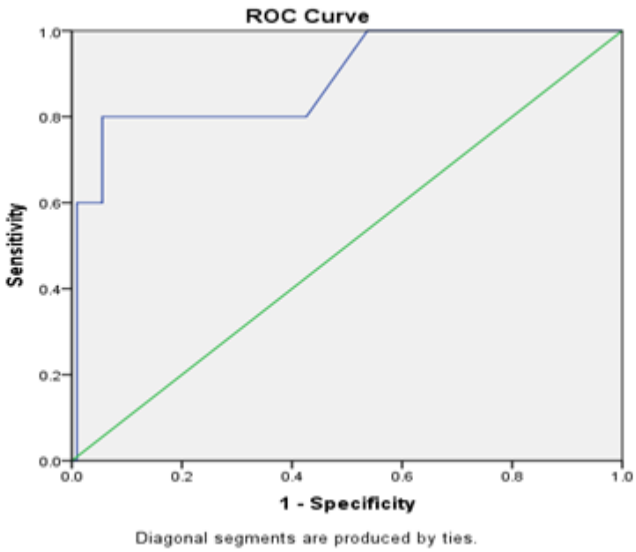

Figure 3: Receiver Operating Characteristic curve for the right eye.

The area under the curve was 0.887 with a standard error of 0.085.

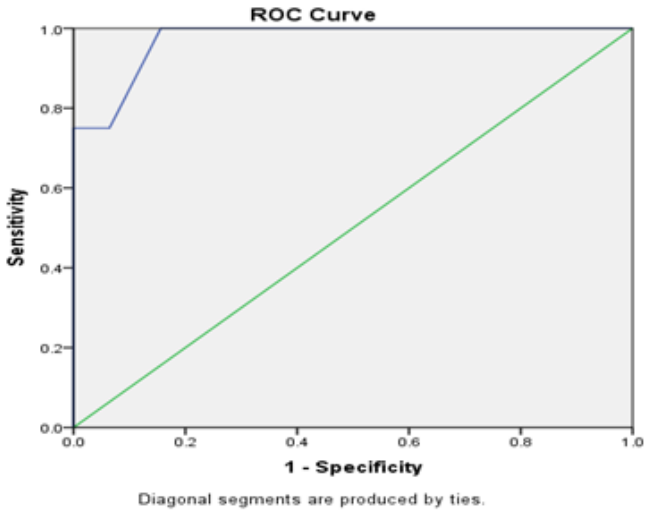

Figure 4: Receiver Operating Characteristic Curve for the left eye.

The area under the curve was 0.972 with a standard error of 0.027.

A scattergram was plotted comparing Tonopen measurements with Goldmann measurements forboth eyes as shown in the following figures.(Figure 5 and 6)

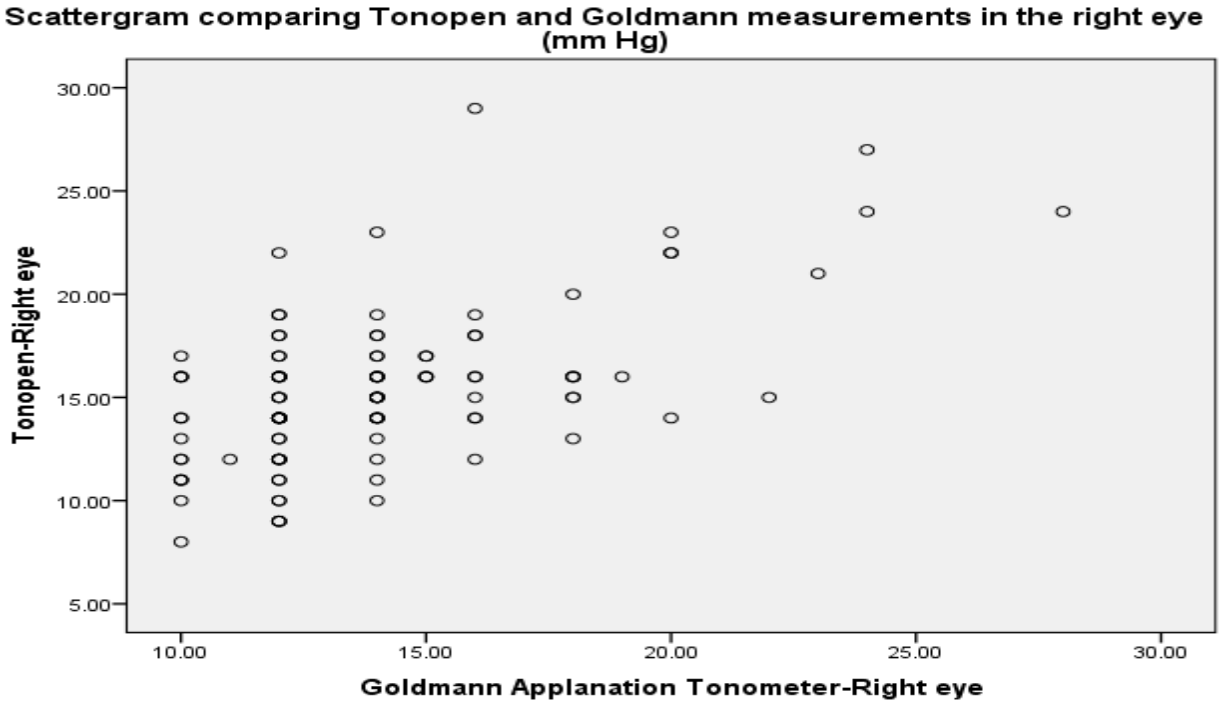

Figure 5

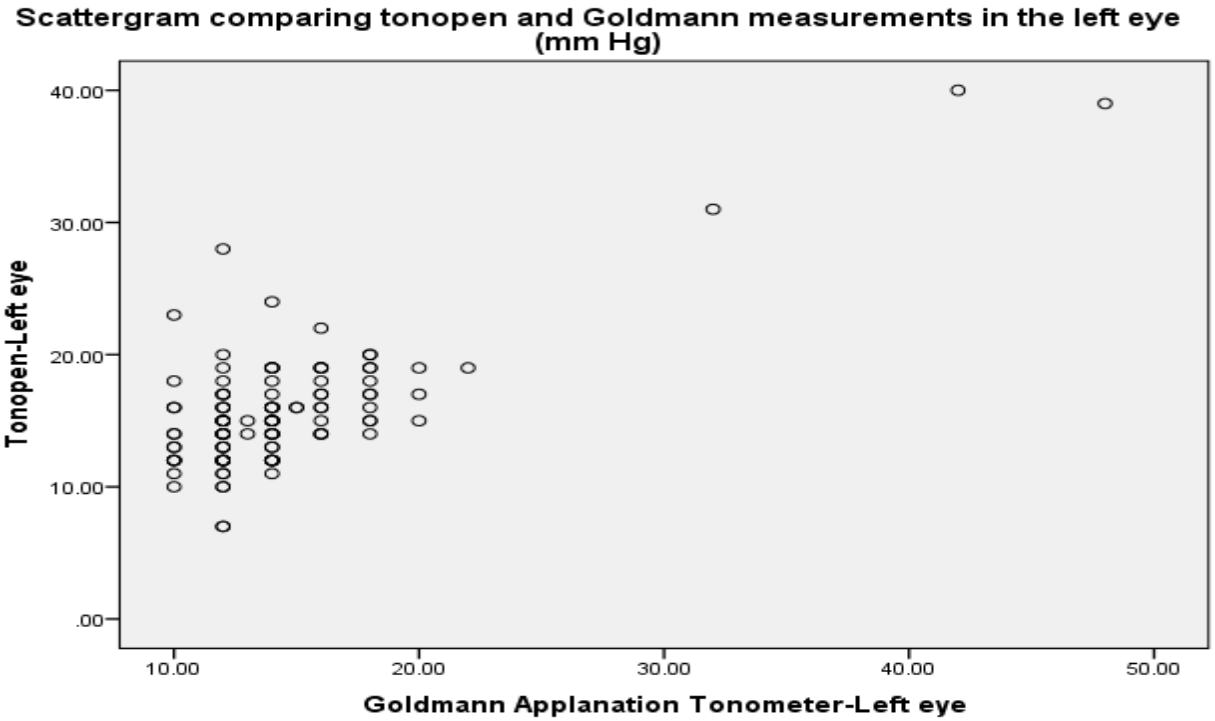

Figure 6

5. Discussion

In recent years, new instruments such as the Tonopen have emerged as alternatives for measuring intraocular pressure to screen for diseases such as glaucoma where timely detection can save many people from blindness. Since, the Tonopen is a simple and convenient method of measuring the IOP as compared to the older instruments such as the Goldmann Applanation Tonometer and the Schiotz Tonometer, it may eventually replace these as screening tests for glaucoma. However, before the Tonopen can be accepted as a reliable indicator of IOP, it is imperative to carry out extensive research otherwise diseases such as glaucoma will remain undiagnosed.

This study focuses on comparing the measurement of intraocular pressure by Tonopen with Goldmann Applanation Tonometer in order to evaluate the accuracy of the Tonopen as a screening test for glaucoma.
The study conducted by Kao SF et al indicates that Tonopen can be used effectively as a screening measure, the sensitivity and specificity obtained in their study in detecting IOP is similar to our study[6]. In the study conducted by Geyer O et al, however, the Tonopen was reported to be inaccurate in measuring IOP.[5] But, in this study, a high accuracy rate was obtained and the area under the ROC curve was suggestive of the Tonopen being a reliable test for screening for glaucoma.

Hence, according to this study, the Tonopen is an accurate and reliable indicator of intraocular pressure. However, further investigations should be carried out to confirm this.

6. Conclusion

The Tonopen is a reliable instrument for measuring the intraocular pressure in screening tests for glaucoma.

7. Acknowledgments

Financial or other competing interests: none

References

[1] Kanski BB. Clinical Ophthalmology. 8th ed. Canada:Elsevier ;2016.307 p.
[2] Kniestedt C, Punjabi O, Lin S, Stamper RL. Tonometry through the ages. Surv Ophthalmol. 2008 Nov; 53(6):568-91.
[3] Lieberman MF, Congdon NG, He M. The Value of Tests in the Diagnosis and Management of Glaucoma. Am J Ophthalmol. 2011 Dec; 152(6):889-99.
[4] Midelfart A, Wigers A. Clinical comparison of the ProTon and Tono-Pen tonometers with the Goldmann applanation tonometer. Br J Ophthalmol. 1994 Dec; 78(12):895-98.
[5] Geyer O, Mayron Y, Loewenstein A, Neudorfer M, Rothkoff L, Lazar M. Tono-Pen tonometry in normal and in post-keratoplasty eyes. Br J Ophthalmol. 1992; 76(9):538-40.
[6] Kao SF, Lichter PR, Bergstrom TJ, Rowe S, Musch DC. Clinical comparison of the Oculab Tono-Pen to the Goldmann applanation tonometer. Ophthalmology. 1987 Dec; 94(12):1541-4.