

# Inter-instrumental agreement between goldman applanation tonometer (GAT) and non-contact tonometer (NCT) in relation to central corneal thickness (CCT) - an entity revisited

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## Abstract

**Background:** To compare the level of intra ocular pressure measured by two different tonometers in relation to central corneal thickness (CCT). **Material and Methods:** Intraocular pressure (IOP) was measured in 118 consecutive patients first by Goldman applanation Tonometer (GAT) followed by Non-contact tonometer (NCT). Central corneal thickness was measured in each case by non-contact method. The values of IOP thus obtained by both the methods were compared in relation to the CCT values. **Results:** Out of total 118 patients, maximum subjects belonged to 31-40 year age-group (n=44). The mean age was 46.5 years. 66 male and 52 female participated in this study. The mean CCT was 517.68 $\mu$ m with standard deviation 26.77. 95 IOP readings were normal with NCT and 14 readings were graded as ocular hypertension (IOP measuring more than 21mm Hg) giving a specificity rate of 95.95% and sensitivity rate of 73.68%. **Conclusion:** In patients with normal range of CCT, GAT remains the method of choice.

**Keywords:** Intraocular pressure; Tonometry; Goldman applanation tonometer; Non-contact tonometer; Central corneal thickness.

Intraocular pressure (IOP), though not an essential criterion to diagnose glaucoma, is a significant and perhaps the only modifiable risk factor in the management of glaucoma. Although glaucoma involves primarily elderly population, it occurs in other younger age-groups as well causing significant economic burden to the society. Goldman applanation tonometer has long been considered the gold standard technique in IOP measurement.<sup>1</sup> Many factors including central corneal thickness (CCT) influence the reading of GAT.<sup>2</sup> Non-contact tonometer (NCT) also

works in the principle based on applanation of the cornea. Being hand held, It is easy to use and can even be used by the paramedics. Against this background, the current study is undertaken to compare the level of IOP measured by these two different Instruments with special relation to CCT.

### Material and methods:

Total 118 consecutive patients aged over 16 years attending Institutional Glaucoma clinic between June 2006

**Table 1: Distribution of CCT according to age and sex**

Age group	Frequency	Male		Sex		
		Mean CCT( $\mu$ m)	SD	Frequency	Mean CCT( $\mu$ m)	SD
31-40yrs	26	514.19	21.69	18	508.33	33.52
41-50yrs	19	525.53	27.87	17	511.24	21.47
51-60yrs	16	519.44	26.95	12	506.50	23.56
61-70yrs	5	519.80	27.66	5	540.20	36.83

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**Table 2: Distribution of IOP values measured by GAT according to age and sex**

Age group	Frequency	Male		Female	
		Mean	SD	Mean	SD
31-40yrs	26	14.92	3.89	18	3.95
41-50yrs	19	17.05	4.39	17	4.42
51-60yrs	16	18	4.84	12	5.22
61-70yrs	5	18.80	5.22	5	16.21

**Table 3: Distribution of IOP values measured by NCT according to age and sex**

Age group	Frequency	Male		Female	
		Mean	SD	Mean	SD
31-40yrs	26	14.38	3.35	18	2.50
41-50yrs	19	16.63	4.35	17	4.25
51-60yrs	16	16.88	4.33	12	4.47
61-70yrs	5	17	3.4	5	12.28

**Table 4: Distribution of IOP measured by GAT and NCT in various CCT ranges**

Range of CCT	IOP measured by GAT and NCT with their paired difference							
	IOP (GAT)			IOP (NCT)			Paired Difference (GAT-NCT)	
Frequency	Mean	SD	Frequency	Mean	SD	Mean	SD	
0.459-0.500 mm	35	15.2	3	35	14.26	2.60	1	1.06
0.501-0.540 mm	62	17.02	6.32	62	16.21	5.45	0.84	1.82
0.541-0.600 mm	21	18.29	5.07	21	16.90	4.10	1.48	2.32

to August 2008 were recruited for the study. The procedures were explained to each of the patients. Institutional Ethics Committee approval was obtained and written informed consent was obtained from each of the participating cases. Each patient underwent applanation tonometry ( Haag-Streit-900 slit-lamp mounted model) followed by non-contact tonometry (Keeler Pulsair Easy Eye, Keeler Ltd., Clewer Hill Road, Windsor, Berkshire, SL4 England) followed by CCT measurement (Topcon, SP-2000P, Japan). The values of IOP thus measured by two different Instruments were compared in relation to CCT.

**Results:**

Out of total 118 patients, maximum subjects belonged to 31-40 year age-group (n=44) followed by 41 to 50 year age-group (n=36). Least number of people belonged to 61 to 70 year age-group (n=10). The mean age was 46.5 years. 66 male and 52 female participated in this study. The mean CCT was 517.68µm with standard deviation 26.77 (Table 1). The mean CCT among male (n=26) in 31-40 year age group was 514.19 µm (SD=21.69), age-group 41-50yrs (n=19) was 525.53 µm (SD=27.87).

The mean CCT was highest in males in the age-group of 41-50 yrs and among females in 61-70 yrs age-group. The IOP measured by GAT ranged from 10-50mm Hg (mean IOP=16.70MM Hg, SD=5.38). The IOP measured by NCT ranged from 10 to 42 mm Hg (mean=15.75 mm Hg, SD=4.59).

The mean IOP measured by GAT among male was highest in 61-70yrs age group (18.80mm Hg, n=5, SD=5.22) and lowest in 31-40yrs age-group (14.92mm Hg, n=26, SD=3.89). The mean IOP among females measured by GAT was highest in 61-70yrs age-group (21.6mm Hg, n=5, SD=16.21) and lowest in 31-40yrs age-group (14.89mm Hg, n=18, SD=3.95). (Table no 2)

The mean IOP measured by NCT among male was highest in 61-70yrs age group (17.00mm Hg, n=5, SD=3.4) and lowest in 31-40yrs age-group (14.38mm Hg, n=26, SD=3.35). The mean IOP among females measured by NCT was highest in 61-70yrs age-group (20.6mm Hg, n=5, SD=12.28) and lowest in 31-40yrs age-group (13.5mm Hg, n=18, SD=2.50). (Table no 3)

95 IOP readings were normal with NCT and 14 readings were graded as ocular hypertension(IOP measuring more than 21mm Hg) giving a specificity rate of 95.95% and sensitivity rate of 73.68%.Table number 4 depicts the distribution of IOP values by GAT and NCT in various CCT ranges. The mean IOP value as measured by GAT, in the CCT range of 0.459-0.500mm was 15.2mm Hg (SD=3). The mean IOP measured by GAT in the CCT range of 0.501-0.540mm was 17.07mm Hg (SD=6.32, n=62).

### Discussion:

In 1963, Luntz et al in an Oxford study study, compared GAT with Schiottz tonometer.<sup>3</sup>Leydhenker conducted a trial in South India and concluded that at an IOP more than 21mm Hg, GAT had a good correlation with IOP.<sup>4</sup>Tonnu et al found moderate agreement between GAT and NCT.<sup>5</sup> According to Bhan et al, tono-pen is least affected by CCT when used to measure IOP in eyes with normal corneas. According to them, pneumotonometer is more affected by variation in CCT than GAT.<sup>6</sup> Though a study from Taipei

showed that almost all the modalities of IOP measurement is affected by CCT, NCT being most affected and GAT being least affected.<sup>7</sup> If the IOP measurement under mean 18mm HG GAT is considered, the difference between GAT and NCT was not significant as opposed to the GAT measurements above 18mm Hg, where a highly significant difference between the means was found( $p=0.0033$ ).<sup>8</sup> The NCT may be used for screening patients having normal IOP.<sup>9</sup> We may conclude that GAT remains the gold standard for measurement of IOP, though the readings are influenced by CCT values.

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