Tonometry, in reference to the eye, is the noninvasive measurement of intraocular pressure.

A tonometer is an instrument that exploits the physical properties of the eye to permit measurement of pressure without the need to cannulate the eye.

Tonometers in which the intraocular pressure is negligibly raised during intraocular pressure measurements, less than 5%, are termed low-displacement tonometers. Eg. Goldmann Applanation Tonometer, Mackay-Marg tonometer.

Tonometers that displace a large volume of fluid and consequently raise intraocular pressure significantly are termed high-displacement tonometers. High-displacement tonometers are less accurate. Eg. Schiotz, Maklakov.

Tonometers can be classified into:

i) Indentation tonometers

Schiotz tonometer: IOP measurement is based on volume change before and after placement. The schiotz tonometer was calibrated by Friedenwald, based on invitro & invivo manometric studies in 1948. The scale readings are converted into IOP values from the Friedenwald nomogram.

It is easier to use during mass screenings, less accurate and variables like ocular rigidity, corneal thickness, variable expulsion of intraocular blood etc. affect the reading.

ii) Applanation tonometers

The Imbert-Fick principle: When a plane surface is applied to a flexible sphere with a force (F) causing an area (A) to be flattened, the pressure inside the sphere, \( P_t = F/A \)

2 types: Variable force & Variable area

A) Variable force type (Constant area) applanation tonometers - Contact Type

Goldmann tonometer: Considered to be the gold standard. Calibrated for 550µCCT
Perkins tonometer: Hand held. Similar to Goldmann tonometer
Draeger tonometer: Hand held, Similar to Perkins
- Uses an optical element, a biprism.
- Needs fluorescien staining.
- CCT correction to be made to measured IOP

Mackay-Marg tonometer: Electronically controlled plunger measures IOP; traced on a paper strip. No optical element.

Tonometers based on Mackay-Marg

Tonopen: portable, hand held. Electronic strain guage readings converted into IOP values.

Pneumotonometer: Pneumatically controlled sensing head. No plunger.

Note: Mackay-Marg type tonometers are less affected by corneal irregularities, as they don’t have an optical element.

- Both are useful in corneal edema & scarring.
- Can also measure over soft/bandage contact lens.
- Can also measure on peripheral corneas

B) Variable force type (Constant area) applanation tonometers - Non-Contact Type

Air-puff tonometer (Invented by Grolman)

Optoelectronic sensor measures light reflected from cornea, applanated by a collimated jet of air. The time lag between various stages of applanation is converted into IOP readings. Eg: Pulsair

Advantages: No risk infection, no anaesthetic, can be used in children and for mass screening

Ocular Response Analyser

This air-puff tonometer. It can measure the Cornea Compensated IOP (independent of corneal thickness), Goldmann Correlated IOP, Corneal Rigidity Factor (Correlates well with corneal CCT) and Corneal Hysteresis (Viscous damping property of cornea). Eyes with low Corneal Hysteresis are more susceptible to ONH damage from IOP fluctuations, due to poor damping.

C) Variable area (Constant force) type applanation tonometers – Contact Type

Maklakov tonometer

The area of cornea applanated by a known force is measured. Dumbbell-shaped metal cylinders of different weights are used. The diameter of the applanated area can be measured from the imprint created by the contact with instrument. IOP read from a conversion table. Displaces a large volume of fluid.
fluid, affected by ocular rigidity. less accurate but portable.

**iii) Non-applanating type, Contact tonometers**

**Dynamic Contour Tonometer**

Measuring head matches the contour of cornea. Hence, minimal or zero applanation. The appostional force of 1 gm is constant. It electronically measures IOP via a piezo-resistive sensor built into measuring head. Not affected by corneal rigidity.

Capable of continuous IOP measurement. Slitlamp mounted instrument.

**Rebound tonometer**

The rebound characteristics of a probe after its momentary contact with cornea, like, deceleration, contact time etc are analysed through complex algorithms by a software to measure the IOP. No topical anaesthesia required. Its calibrated for average CCT’s like the Goldmann tonometer, hence affected of CCT. Handheld device.

Can be used in children and uncooperative adults

**Disinfection of tonometers**

For contact type tonometers, the risk of transmitting viral contaminants like Adenovirus, HBV, HTLV-III and other bacterial pathogen is high. Wiping with 3% Hydrogen Peroxide or 70% Isopropyl alcohol disinfects the tonometer heads.

Using disposable covers over the measuring head in Makay-Marg type tonometers can help prevent spread of pathogens.

<table>
<thead>
<tr>
<th>Type of tonometer</th>
<th>Advantages</th>
<th>Influence of CCT</th>
<th>Other parameters</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Applanation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GAT</td>
<td>Accepted gold standard</td>
<td>Yes</td>
<td></td>
<td>Not for patients in supine position</td>
</tr>
<tr>
<td>Perkin's</td>
<td></td>
<td>Yes</td>
<td></td>
<td>Poor accuracy in irregular cornea</td>
</tr>
<tr>
<td><strong>Mackay-Marg Type</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pneumotonometer</td>
<td>1+2+4+5</td>
<td>Yes</td>
<td></td>
<td>Outflow facility</td>
</tr>
<tr>
<td>Rebound tonometer</td>
<td>Portable Supine position Measures peripheral cornea No need of anaesthesia</td>
<td>Yes</td>
<td></td>
<td>• Affected by corneal viscosity and CCT</td>
</tr>
<tr>
<td>Dynamic Contour Tonometer</td>
<td>Data not affected by CCT</td>
<td>No</td>
<td>Ocular pulse amplitude</td>
<td>• Poor in irregular cornea • Difficult to use</td>
</tr>
<tr>
<td><strong>Air puff tonometer</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ocular Response Analyzer</td>
<td>CH also No anaesthesia Non contact Corrected for CCT</td>
<td>No</td>
<td>CH,CRF, IOPcc</td>
<td>• Not possible in supine position • Instability of data</td>
</tr>
<tr>
<td>Non Contact Tonometer</td>
<td>No anaesthesia Non contact Mass screening</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Schiotz

Rebound tonometer

Draeger

Goldman applanation

Maklakov

DCT

Mackay Marg

ORA

Pulse air puff

Tonopen
The Kerala Journal of Ophthalmology (KJO) is a quarterly, peer reviewed one, devoted to dissemination of the latest in ophthalmology to the General Ophthalmologists as well as to specialists in the various subspecialties of this discipline. It invites submission of original work dealing with clinical and laboratory materials.

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1. TITLE: The title of the work must be brief and precise. It should not exceed two lines and 40 characters (including comma, period) Author(s) full name(s) must be given along with his (their) degree and the affiliations. Corresponding author’s name, correct address (including e-mail and Fax, if available) and phone number must be mentioned at the bottom left hand corner of the first page.

2. ABSTRACT: The abstract is to be given in the beginning itself. It should not exceed 200 words. It must contain the aim, methodology, results and conclusion. For case report, summary/conclusion alone is to be given.

3. INTRODUCTION: Describe the aim of the study, along with the hypotheses that were tested. Only necessary references are to be given.

4. METHOD: Give in detail the materials used and the methods employed. Describe the type of study. Pharmacological names only must be mentioned for the drugs used and, if proprietary name is used, then the manufacturers name must be given in parentheses. Except for standard, well-accepted abbreviations (including SI Units), all others must be introduced in parentheses when the full term is used for the first time in the article.

5. RESULTS: Give only the results obtained by the study under discussion. State the statistics in the correct scientific form (P value, mean etc). Results based on assumptions must not be given. Indicate in the text the place where the tables have to be inserted.

6. DISCUSSION: The discussion should be to the point and relevant to the subject under discussion. This section can be combined with the previous one if the author desires. Avoid speculations. Use only standard abbreviations or the abbreviations already introduced.

7. ACKNOWLEDGEMENT: This is to be made only to those who were directly and scientifically involved with the preparation of the paper. Permitting authorities, technicians, photographers who assisted in the work need not be mentioned.

8. REFERENCES: The references should be given in numerical order in which they first appear in text and not in alphabetical order (Citation Order System). It should be numbered consecutively in the text. The references will not be checked by the Editor or by the Peer reviewer and hence the author is solely responsible for its completeness and the accuracy. Period should not be employed anywhere in the references. Personal communications, unpublished data and poster references, if mentioned, should be in the text itself and the source mentioned in parentheses. References should be in the following form:

   Journal reference: Author(s) full title, Journal name (as abbreviated in Index Medicus), volume number, pages and year. If there are more than three authors, then mention the first three authors and then ‘et al’.

   Book reference: Author(s) & Editor, if any, title of book (and chapter), publisher, place of publication, page number(s) of the cited portion and year.

9. THE LEGEND: The legend for the illustrations (and tables, if necessary) must be given in a separate sheet of paper and should be typed double-spaced.
Illustrations: The photos and figures should be prepared in glossy prints with good contrast and of the size 6” x 4”. Only salient details should be included. On the back of the illustration, the figure number in text, title of the paper, the first author’s name and the top side (marked with an arrow) must be specified. Except for arrows, no text is to be on the photos. It is the duty of the author(s) to get the patient’s written permission when the subject is identifiable in the photo. Submit two sets of illustrations. Illustrations from other Journals and books are usually not accepted. If used, it rests with the author(s) to get the copy right permission from the original author / publisher and this permission letter must be sent to the Editor at the time of submitting the manuscript. For Histological figures the stain and magnification used should be noted e.g.: H & E Stain x 70.

10. TABLE: It should be in double space. Each table must have an Arabic numeral (except for single table) and a title both in a single line. Each column in the table must have a short heading. If a table is large, then it must be continued in a second page, which also must have the table number and the title. Avoid vertical lines in the tables. Two sets must be submitted.

11. All manuscripts are subjected to editorial board review.

12. Other Categories of Manuscript

a) Original Articles should generally not exceed 3,000 words or 12 double – spaced pages.

b) Review Articles: can be on topics of relevance to clinical practice, research methodology, community ophthalmology or investigative work, of relevance to visual science. These articles should include up to date review of existing literature, and summarize the current status / preferred practice for that particular topic.

Brief reports are short communication of new instruments, new laboratory techniques or surgical techniques as well as interesting case reports with unique findings. These should not exceed 1000 words with a maximum of 2 illustrations. They should follow the format – introduction, case, and discussion. No more than 8 references should be cited. Each brief report must begin with a 75-100 word summary that highlights the significance of the articles.

In the September 2009 KJO issue the name of the second author of the original article OCULAR MANIFESTATIONS OF INTRACRANIAL SPACE OCCUPYING LESIONS is wrongly typed as DR ANJU. The second author is DR SANDHYA SOMASUNDARAN.