# Tonometry

**Tonometry** is the measurement of tension or pressure [1]. A **tonometer** is an instrument for measuring tension or pressure [1].

In music, a tonometer is an instrument used to determine the pitch or vibration rate of tones, such as a tuning fork.

In ophthalmology, tonometry is the procedure eye care professionals perform to determine the intraocular pressure (IOP), the fluid pressure inside the eye. It is an important test in the evaluation of patients with glaucoma. Most tonometers are calibrated to measure pressure in mmHg.
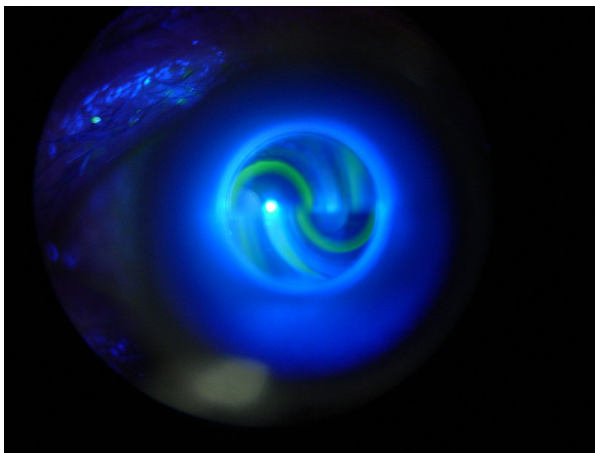

A patient in front of a tonometer

## Methods
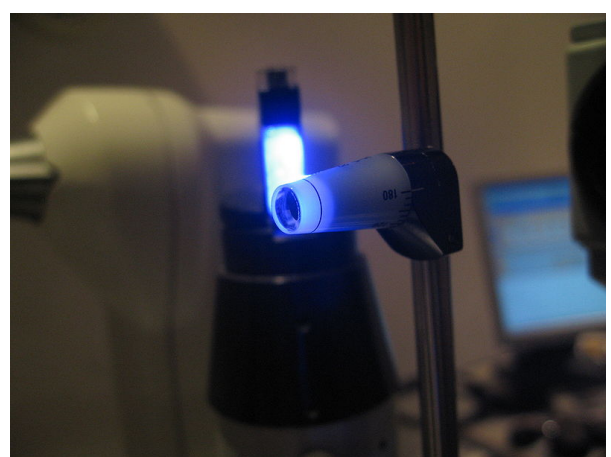

The slit lamp of a Goldmann tonometer

Semicircles seen during Goldmann tonometry through slit lamp


The PASCAL Dynamic Contour Tonometer

- **Applanation tonometry** is the method used by some tonometers, the Maklakoff one being an early example, that infers the intraocular pressure from the force required to flatten (applanate) a constant area of the cornea (3.06mm using the Goldmann tonometry) .[2]

A special disinfected prism is mounted on the tonometer head and then placed against the cornea. The examiner then uses a cobalt blue filter to view two green semi circles. The force applied to the tonometer head is then adjusted using the dial until the inner edges of these green semicircles meet. Because the probe makes contact with the cornea, a topical anesthetic, such as oxybuprocaine, tetracaine, proparacaine (alcaine) or proxymetacaine is introduced onto the surface of the eye in the form of an eye drops.
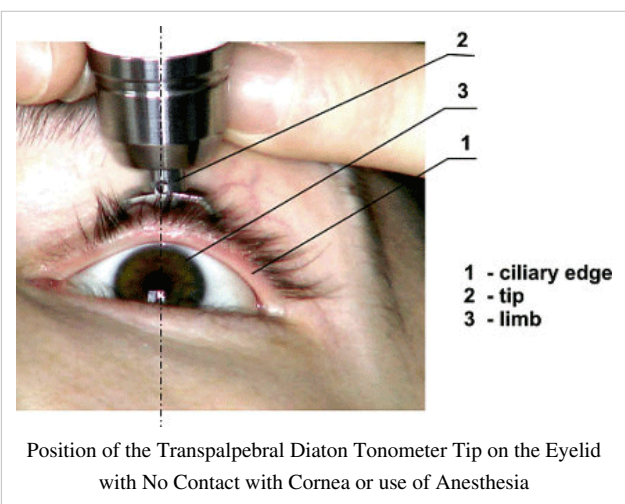

Position of the Transpalpebral Diaton Tonometer Tip on the Eyelid with No Contact with Cornea or use of Anesthesia

- **Goldmann tonometry** is considered to be the gold standard in tonometry as it is the most widely accepted method of determining approximate intraocular pressure.[3] [4] James D. Brandt, MD,gives a dissenting opinion that [5], Goldmann tonometry is an inherently imprecise measurement. Goldmann tonometer principle is based on the Imbert-Fick law.



Hand-held Diaton tonometer with Test and Training Eye case

- **Dynamic contour tonometry**

Dynamic contour tonometry (DCT) is a novel method which uses principle of **contour matching** instead of applanation. This is designed to reduce the influence of biomechanical properties of the cornea on measurement. These include corneal thickness, rigidity, curvature, and elastic properties. It is less influenced by corneal thickness but more influenced by corneal curvature than the Goldmann tonometer.[6]

The PASCAL tonometer is currently the only commercial DCT tonometer available. It uses a miniature pressure sensor embedded within a tonometer tip contour-matched to the shape of the cornea. The tonometer tip rests on the cornea with a constant appositional force of one gram. When the sensor is subjected to a change in pressure, the electrical resistance is altered and the PASCAL's computer calculates a change in pressure in concordance with the change in resistance.

The contour matched tip has a concave surface of radius 10.5 mm, which approximates to the shape of a normal cornea when the pressure on both sides is equal. The probe is placed adjacent to the central cornea (see gallery) and the integrated piezoresistive pressure sensor automatically begins to acquire data, measuring IOP 100 times per second. A complete measurement cycle requires about 8 seconds of contact time. During the measurement cycle, audio feedback is generated, which helps the clinician maintain proper contact with the cornea. The device also measures the variation in pressure that occurs with the cardiac cycle. Literature references: [7] [8] [9]

- **Non-corneal and Transpalpebral tonometry**

Diaton tonometer [10] (BiCOM, Inc) Transpalpebral tonometry refers to methods of measuring intraocular pressure **through the Eyelid**. The Diaton Non-corneal tonometer calculates pressure by measuring the response of a free falling rod, the principle is based on Newton's second law, as it rebounds against the tarsal plate of the eyelid through the sclera, independent of the corneal parameters. The patient is positioned so that the tip of the device and lid are overlying sclera, allowing to take **Non-corneal** measurement. <ref name="[11] . Non-corneal and transpalpebral tonometry does not involve contact with the cornea and does not require sterilization of the device or topical anesthetic during routine use. Latest studies show good correlation between Goldmann and Diaton tonometers <ref name="[12] .

- **Non-contact tonometry** or **air-puff tonometry** Non-contact tonometry is different from pneumatonometry and was invented by Bernard Grolman of Reichert, Inc (formerly American Optical). It uses a rapid air pulse to applanate the cornea. Corneal applanation is detected via an electro-optical system. Intraocular pressure is estimated by detecting the force of the air jet at the instance of applanation.[13] Historically, Non-contact tonometers were not considered to be an accurate way to measure IOP but instead a fast and simple way to screen for high IOP. However, modern non-contact tonometers have been shown to correlate well with Goldmann tonomtery measurements and are particularly useful for measuring IOP in children and other non-compliant patient groups. **non-contact tonometry** is accomplished without the instrument contacting the cornea which reduces the potential for disease transmission.
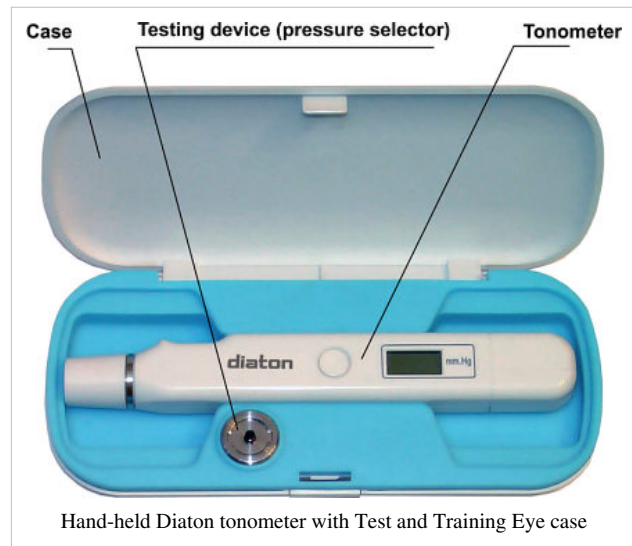
- **Electronic indentation tonometry**. The **Tono-Pen (Reichert, Inc)** is a portable electronic, digital pen-like instrument that determines IOP by making contact with the cornea, after use of topical anesthetic eye drops. This is especially useful for very young children, patients unable to reach a slit lamp due to disability, patients who are uncooperative during applanation tonometry, or patients with cornea disease in whom contact tonometer cannot be accurately performed.

- **Pneumatonometry** A pneumatonometer utilizes a pneumatic sensor (consisting of a piston floating on an air bearing). It is touched to the anesthetized cornea. A precisely regulated flow of filtered air (from an internal air pump) enters the piston. A small (5-mm dia.) fenestrated membrane at the end of the piston reacts to both the force of the air blowing through it and to the force represented by the pressure behind the cornea, against which it is being pressed. The precise balance between these two forces represents the precise intra-ocular pressure (I.O.P.)

- **Impression tonometry**, also known as **indentation tonometry**, measures the depth of the impression produced by a small plunger carrying a known weight.[14] Intraocular pressure is determined by assessing the movement of the plunger to a calibrated scale.[14]

- **Rebound tonometry**

Rebound tonometers ([Icare Tonometer http:/ / www. icaretonometer. com]) determine intraocular pressure by bouncing a small plastic tipped metal probe against the cornea. The device uses an induction coil to magnetise the probe and fire it against the cornea. As the probe bounces against the cornea and back in to the device it creates an induction current from which the intraocular pressure is calculated. The device is simple, cheap and easy to use. It is portable, does not require the use of eye drops and is particularly suitable for children.

- **Schiötz tonometry** is a type of indentation tonometery, historically was used to determine IOP. This type of tonometry makes use of a plunger to indent the cornea. The IOP is determined by correlation of scale reading using a nomogram, with additional small metal weights added for higher levels of IOP.

- **Perkins tonometer** is a special type of portable applanation tonometer, which allows measurement of IOP in children, patients unable to cooperate for slit lamp exam, and in anesthetised patients who may be in a supine position.

- **MacKay Marg** tonometer

- **Palpation**, also known as **digital tonometry**, is the method of estimating intraocular pressure by pressing gently against the cornea of a closed eye with your index finger.[15]

- **Ocular response analyzer** The ocular response analyser (ORA) is a non-contact (air puff ) tonometer that does not require topical anaesthesia and provides additional information on the biomechanical properties of the cornea. It uses an air pulse to deform the cornea in to a slight concavity. The difference between the pressures at which the cornea flattens inward and outward is measured by the machine and termed corneal hysteresis (CH). The machine uses this value to correct for the effects of the cornea on measurement [16]
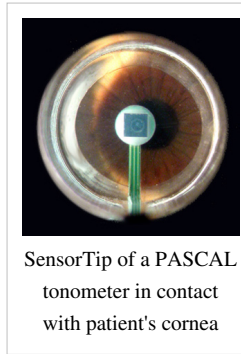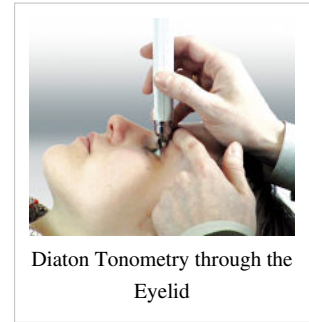
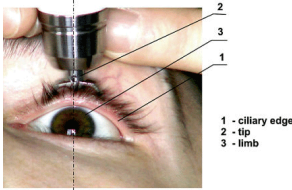## Gallery



A Goldmann tonometer
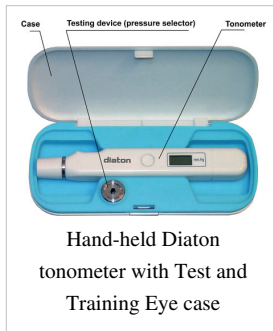


PASCAL Dynamic Contour Tonometer



SensorTip of a PASCAL tonometer in contact with patient's cornea



Diaton Tonometry through the Eyelid



Position of the Diaton Tonometer Tip on the Eyelid with No Contact with Cornea or use of Anesthesia



Hand-held Diaton tonometer with Test and Training Eye case

## External links

- Tonometry - WebMD [17]
- Tonometry - *The Johns Hopkins Consumer Guide to Medical Tests* [18]
- Kirstein, E. "An Update on Methods for Assessing Intraocular Pressure." [19] Retrieved June 7, 2006.
- Tonometry- *Transpalpebral Diaton Tonometry* [20]
- Rebound Tonometer from Icare Finland [21]
- Trans-Scleral Tonometry [22]
- Tonometers in the market [23]
- Tonometer from Keeler Ltd, UK based Company [24]
- Through Eyelid Tonometer from BiCOM Inc. [25]

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[13] http://www.mercksource.com/pp/us/cns/cns_hl_dorlands. jspzQzpgzEzzSzppdocszSzuszSzcommonzSzdorlandszSzdorlandzSzdmd_t_13zPzhtm

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[18] http://www.hopkinsafter50.com/html/silos/vision/viLIB_JHMT_Tonometry.php

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[20] http://www.tonometerdiaton.com/index.php?do=home.description

[21] http://www.icaretonometer.com

[22] http://www.tonometerdiaton.com

[23] http://www.optivision2020.com/tonometer.html

[24] http://www.keeler.co.uk/

[25] http://www.tonometer.net

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