

Tonometers

An introduction to Instrumentation

Notes to accompany City University 2nd year undergraduate Clinical Practice course lecture

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Acknowledgements & suggested reading

Henson D (1983) *Optometric Instrumentation*. Butterworths, London

Fingeret et al (1990) *Atlas of Primary Eye Care Procedures*, Appleton & Lange, Norwalk

Introduction

Recently Government directives have been received suggesting that instruments that come in to contact with the eye may need to be disposed of after a single use due to suggested risks from BSE/CJD. The exact position is unclear with regard to tonometers (1st November 1999) but students should be aware of the situation. Note that an advantage of non-contact tonometers is that they do not touch the eye.

Indentation tonometers

If a plunger of known weight is rested on the cornea, the depth of plunger indentation should (?) be proportional to IOP.

Note: ocular rigidity/facility of aqueous outflow (see separate lecture on tonometry).

The plunger may be connected to lever arm and scale (e.g. Schiötz) or to electronic recording system (e.g. Mueller).

Schiötz tonometer (1905)

The footplate is rested on the cornea and the plunger is free to indent the cornea. A variety of weights may be used to minimise errors due to corneal rigidity (use with tables).

normal weight (knurled knob above footplate) = 5.5grams giving a total of 16.5 grams to be supported by the cornea. Additional weights are 7.5, 10, 15 grams

Disadvantages

- 1) Heavy & potentially dangerous (total weight 50g)
- 2) Corneal abrasions more likely
- 3) Difficult to disinfect – note also CJD risk (?)
- 4) Displacement of aqueous
- 5) Effect of corneal rigidity on reading

Advantages

- 1) Cheap
- 2) Portable
- 3) Can be done on supine px
- 4) Can measure ocular tension of eye with scarred cornea

Applanation tonometers

Imbert Fick Law - for a perfectly dry, elastic, spherical body, whose wall is infinitely thin, then the diameter flattened is \propto to force applied. Cornea does not fit this category BUT the statement does approximate under certain conditions.

Constant force – variable area

e.g., *Maklakoff* - dumbbell shaped weight held by "pincers." The weight \therefore force is known. ? diameter of cornea flattened. Silver proteinate "disinfectant"

Accuracy ? \pm 5 mmHg. Need to measure to 0.1 mm. Historical.

More modern version is the *Tonomat*. Advantage - portability

Constant area – variable force

If 3.06 mm flattened then IOP supposedly \propto force applied

e.g.s,

Gamb's

Goldmann tonometer

Doubling prism to separate images by 3.06 mm

Method of choice. Used for comparing calibrate new instruments.

Advantages

- 1) easy to use
- 2) cheap
- 3) comfortable (apart from anaesthetic)
- 4) quick

Disadvantages

- 1) need for anaesthetic
- 2) cannot be delegated
- 3) contact with cornea (slight chance of abrasion)

Sources of error

- 1) lids touching cone
- 2) surface tension effects (CL wetting soln)
- 3) dirty cone
- 4) high astigmatism (rotate cone)
- 5) tear meniscus too wide

***Perkins* - hand held**

Mackay Marg

Applanation by 3mm diameter probe through which friction free plunger (diam 1.5mm) is able to move 2 microns. As cornea is applanated the cornea exerts pressure on end of plunger and this is monitored and measured by recording amplifier.

No anaesthetic (?)

Pneumotonometers

e.g. OBF tonometer. Samples 200 IOP readings per second. Requires anaesthetic. Disposable membrane tips for tonometer head. IOP measured following applanation by determining resistance to air flow. Major advantage reported to be that corneal rigidity/thickness does not affect readings.

Non contact techniques

AO ⇒ Reichert & others

Puff of air produced by piston and aimed towards cornea. Time taken from onset of puff to point when applanation occurs is measured. Pressure of air increases linearly with time over 10ms after which pressure falls off again.

During this process a beam of light is projected on to the cornea and the amount of light reflected is monitored. The maximum of light reflected to a sensor occurs at the point of applanation. The time taken is recorded and computed by the instrument to produce a reading of ocular tension in mmHg.

Advantages

- 1) quick**
- 2) no anaesthetic required**
- 3) may be delegated**
- 4) non-contact appears to be advantageous re: BSE/CJD "risk"**

Disadvantages

- 1) uncomfortable to some patients**
- 2) expensive**
- 3) difficult to obtain reading on scarred corneas**
- 4) 2 cases of PVD following non-contact tonometry have been reported
(very rare)**

Keeler Pulsair

Ramped air impulse delivered to the eye and the pressure of the air at the point of applanation is gauged. Hand held. Good for infants/children. Latest version shows improved agreement with Goldmann.

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