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Abstract Information

Abstract Title:
The effects of corneal biomechanical properties on intraocular pressure measurement

Purpose:
Central corneal thickness (CCT) influences intraocular pressure (IOP) measurement, and the cornea stiffens with age. Two new tonometers (Dynamic Contour Tonometer [DCT] and Ocular Response Analyzer [ORA]) have been introduced. The DCT eliminates corneal contributions to measured IOP. The ORA, an air-puff tonometer, measures two applanations (as the pressure rises and falls) – the difference representing a viscoelastic property called corneal hysteresis (CH). The purpose of these studies was to i) calibrate the ORA and ii) establish the effects of CCT and age on DCT, ORA and Goldmann applanation tonometry (GAT) IOP measurements.

Design:
i) Experimental study and ii) cross-sectional study

Participants:
i) 45 untreated ocular hypertensive (OHT) and 60 normal subjects (average age 60, range 26 - 82 years) and ii) 130 normal, OHT and glaucomatous subjects (average age 61, range 22 - 83 years)

Main Outcome Measures:
the association of CH with CCT and age; agreement between GAT, ORA and DCT; the effect of CCT on measured IOP, and the effect of CCT and age on tonometer differences (power 93.5% at p = 0.05 (two-sided) for r = 0.30)

Methods:
i) baseline GAT IOP and ORA 1st applanation (P1) and CH were measured in both eyes. Iopidine drops were administered to one randomly selected eye. After 3 hours GAT and ORA measurements were repeated. The association of change in P1 and change in CH was evaluated (power 87.5% at p = 0.05 (two-sided) for r = 0.30). The relationship between P1 and CH was used to normalise CH (nCH) for P1. CH was further normalised for age. ORA IOP was defined as P1 minus

nCH and calibrated against GAT and CCT by multiple linear regression of (P1-nCH).
ii) GAT, ORA and DCT measurements (5 minutes between readings) were made in a randomised order.

Results:
i) change in CH was significantly associated with change in P1 (R2 =0.14, p = 0.001). nCH was significantly associated with CCT (slope 0.227, R2 =0.30, p<0.0001) and age (slope -0.269, R2 =0.04, p=0.04).
ii) the slope (per 100 microm increase in CCT) of the association of IOP with CCT was 3.2mmHg (p=0.003) for GAT, 2.4mmHg (p=0.004) for ORA and 1.3mmHg (p=0.18) for DCT. The agreement (mean difference +/- 95% limits of agreement) was -0.8 +/- 5.5mmHg for GAT/DCT, -2.1 +/- 4.5mmHg for GAT/ORA and -1.3 +/- 5.0mmHg for DCT/ORA. GAT/DCT and GAT/ORA IOP differences increased with age: slope 0.05mmHg (R2 =0.05, p=0.01) and 0.05mmHg (R2 =0.08, p=0.001), respectively. GAT/DCT and DCT/ORA differences were associated with CCT (per 100 microm): slope 2.0mmHg (R2 =0.07, p=0.003) and 1.1mmHg (R2 =0.03, p=0.07).

Conclusion:
CCT affects GAT significantly more than DCT, with an intermediate effect on ORA. CH is significantly greater in thicker corneas, and reduces with age. GAT/DCT differences significantly increase with age. These findings suggest that the cornea stiffens with age, but becomes less viscoelastic.