unilateral cases.¹ Oval or round choroidal osteoma lesions with scalloped margins range from 2 to 22 mm in basal breadth and 0.5 to 2 mm in height, with pseudopodial extensions, surface telangiectases and altered pigmentation.¹ Central serous retinopathy has been associated with choroidal osteomas.^{1,5} FFA reveals an early patchy hyperfluorescence and diffuse late staining with vascular tufts on the vitreal surface of the tumour that fill in the early phases.¹ CT scan demonstrates a radiopaque "bone-like" density of the lesion. Osteomas seem hyperintense on T1-weighted and hypointense on the T2-weighted MRI images.¹

Choroidal osteomas must be distinguished by ultrasound/CT scan from adult vitelliform macular dystrophy, serpinginous chorioretinitis, central serous chorioretinopathy, calcified granulomas, trauma, Cogan's plaques and chorioretinal scarring.^{1,2}

Idiopathic choroidal calcification has been associated with Rieger anomaly, limbal dermoids, retinitis pigmentosa, spontaneous choroidal haemorrhage, organoid nevus, epidermal nevus, Bartter and Gitelman's syndromes.

The pathogenesis in choroidal osteoma is unknown. Although an association of choroidal osteoma with Stargardt's maculopathy may be coincidental, the association could be related to a dysfunction of the retinal pigment epithelium or choriocapillaries. Complicated extrafoveal CNVM are treated with photocoagulation/photodynamic/transpupillary thermo therapy. Submacular surgery is indicated in subfoveal CNVM or haemorrhage.¹

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Agreement between two non-contact specular microscopes: Topcon SP2000P versus Rhine-Tec

Endothelial cell density (ECD) assessment with the noncontact Topcon SP2000P specular microscope is known to be reliable when the automated mode is followed by manual corrections (touched-up mode). We compared its agreement with Rhine-Tec, a new noncontact specular microscope, in 270 eyes of 160 patients, by comparing the ECD measured in the automated and touched-up modes with that of Topcon touched-up. Good agreement existed between either touched-up modes with a mean difference of only 2 cells/mm² 95% CI (-27; 23) whereas agreement with the Rhine-Tec automated mode was poor with an overestimation by a mean of 226 cells/mm² 95% CI (172; 281).

Background

The Topcon SP2000P non-contact specular microscope (Topcon, Tokyo, Japan) is widely used to measure corneal endothelial cell density (ECD). It uses a cell contour recognition algorithm based on contrast differences, and ECD derived from an automated delineation of cell boundaries with manual correction of inaccurately drawn cells ("touched-up" mode) has been validated.^{1,2} A new commercially available non-contact specular microscope Rhine-Tec (Rhine-Tec, Krefeld, Germany) determines ECD by a cell-centre method consisting of identification of centres of contiguous cells either in an automated or a touched-up mode using an operator-defined

cell centre. We aimed to determine its agreement with the Topcon touched-up mode.

Methods

The central endothelium of 270 eyes of 160 subjects (healthy subjects and those operated on for cataract or penetrating keratoplasty to explore a wide range of ECDs) was imaged, first with the Topcon microscope and immediately afterwards with the Rhine-Tec specular microscope. On each sharpest image, the ECD and percentage of hexagonal cells were determined on the largest possible area by a trained ophthalmologist blinded to the clinical antecedents and choosing the device (Topcon or Rhine-Tec) randomly. Both automated and touched-up modes were used for Rhine-Tec, and the Topcon touched-up served as the reference.^{1,2} Agreement was determined using the Bland-Altman method.³ Means were compared using paired t tests (or non-parametric Wilcoxon's test when required) and results considered significant when $p < 0.05$.

Results

Mean (standard deviation (SD)) number of cells counted was 129 (46) (range 24-219, median 144) for Topcon and 137 (44) (range 47-279, median 136) for Rhine-Tec ($p < 0.001$). Despite a good correlation between the Topcon touched-up and Rhine-Tec automated modes ($y = 0.37x + 1497$, $r = 0.8$, $p < 0.001$), the agreement was poor, with Rhine-Tec overestimating ECD by a mean of 226 cells/mm² 95% CI (172 to 281) (fig 1). A continuous bias in ECD determination characterised by overestimation

Figure 1 Difference against mean graph showing the agreement between the endothelial cell densities (ECDs) obtained with the Topcon touched-up mode compared with the Rhine-Tec automated mode. ECD measured in Topcon touched-up mode ranged from 417 to 3263 cells/mm², with 84 eyes (31%) having <1800 (low ECD), 109 eyes (40%) having between 1800 and 2500 cells/mm² and 77 eyes (29%) having >2500 cells/mm² (high ECD). The solid horizontal line indicated the mean difference between Rhine-Tec and Topcon (226 cells/mm²). The agreement was poor with wide 95% limits of agreement (calculated as mean difference (± 1.96 SD of the difference) of the difference) set between -663 and +1116 cells/mm² (dashed lines). The linear regression line (bold) indicated the significant overestimation of low ECDs and underestimation of high ECDs by Rhine-Tec.

Figure 2 Difference against mean graph showing the agreement between the endothelial cell densities (ECDs) obtained with the Topcon and Rhine-Tec touched-up modes. The solid horizontal line indicated the mean difference between Rhine-Tec and Topcon (2 cells/mm²). The agreement was considered acceptable, with 95% limits of agreement set between -412 and +408 cells/mm² (dashed lines). The feeble slope of the linear regression line (bold) showed that the drift in counting (low to high) according to the ECD was reduced compared with figure 1.

of low ECDs and underestimation of high ones ($p < 0.001$) was observed with the Rhine-Tec automated mode, with maximal effects of this drift visible for low (< 1800) and high (> 2500 cells/mm²) ECDs. Correlation between the either touched-up modes was good ($y = 0.82x + 377$, $r = 0.93$ $p < 0.001$) and agreement was far better with a mean difference of 2 cells/mm² 95% CI (-27 to 23) and narrower bounds of agreements (fig 2). Although the tendency to overestimate low and underestimate high ECDs persisted, it was significantly lower. Mean (SD) percentage hexagonality (calculated in touched-up modes) was 58 (12) (range 14–100, median 59) and 41 (8) (range 14–69, median 41) for Topcon and Rhine-Tec, respectively ($p < 0.001$).

Comments

Both non-contact specular microscopes assess ECD on small cell samples. As observed with Topcon,^{1,2,4} the Rhine-Tec automated mode is also not reliable. However, after manual corrections, Rhine-Tec shows an acceptable agreement with Topcon. Regarding the two bounds of agreement on this sample size, a consistent individual variation remains. The reliability of hexagonality assessment using Topcon was already dealt with.¹ The difference observed with Rhine-Tec remains unexplained and is probably linked to a different image analysis algorithm (proprietary data not available). Information regarding the coefficient of variation of the cell area would be helpful to further evaluate this device.

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Comparison of IOP measurement using GAT and DCT in patients with penetrating keratoplasties

Recent studies evaluating intraocular pressure (IOP) measurements by dynamic contour tonometry (DCT) have shown that they are more comparable to true manometric IOP than Goldmann applanation tonometry (GAT),¹ and less affected by changes in naturally occurring central corneal thickness (CCT)^{2,3} as well as surgically induced thinning of the cornea following laser in situ keratomileusis.⁴ Following penetrating keratoplasty, further errors in the measurement of IOP by GAT may also occur due to irregular astigmatism, and technical difficulties in aligning distorted mires on the tonometer head.

Study

We prospectively studied 10 patients with unilateral keratoplasty to detect a significant difference between the measurement of IOP by GAT and by DCT. Contralateral eyes served as paired controls. six horizontal and six vertical GAT readings were averaged for each study eye and each control eye. Six DCT readings were also taken. Keratometry and corneal topography was performed by the Bausch & Lomb Orbscan IIz, and CCT was measured ultrasonically with the Tomey Corporation Pachymeter SP-3000.

Demographic data of the study population are summarised in table 1.

IOP measurement in both grafts and controls were found to be significantly higher using DCT than GAT ($p = 0.004$ and $p < 0.001$ respectively). The mean difference in IOP measured by DCT against GAT was +2.67 mm Hg (95% C.I. 0.86–4.47) in grafted eyes, compared to a mean difference of +3.26 mm Hg (95% C.I. 2.16–4.35) in controls. An under-reading of true IOP by GAT has also been shown against manometry in cadaver eyes,¹ as well as in vivo.⁵

In grafted eyes, there appeared to be no correlation between CCT and DCT-GAT difference (Pearson's correlation coefficient -0.202, $p = 0.122$), but in controls there was a significant correlation (Pearson's correlation coefficient -0.262, $p = 0.043$). The effect of CCT on IOP measurement by GAT in 56 post-keratoplasty eyes has been previously studied, and again no statistically significant relationship was found.⁶ This unexpected finding could possibly be explained by the alteration in biomechanical forces following keratoplasty such as compliance forces present in the host eye, as well as variable graft-host interface mechanics.

In grafted eyes, there was a significant correlation between amount of astigmatism and DCT-GAT difference (Pearson's correlation coefficient -0.398, $p = 0.002$), but not in controls (Pearson's correlation coefficient 0.142, $p = 0.278$). Corneal curvature has previously been shown to have no significant effect on DCT or GAT measurements in non-PK eyes.⁷ The correlation found in keratoplasty