Ciliary body location in eyes with and without primary congenital glaucoma

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ABSTRACT ●

Objective: To compare the location of ciliary body (CB) in children with and without primary congenital glaucoma (PCG).

Methods: In this cross-sectional study, we enrolled Saudi children who were less than 5 years old. CB distance (CBD) was measured and compared in eyes with PCG (PCG group) and without PCG (control group). CBD was measured with a caliper and defined as the distance between the edge of the corneoscleral limbus and the anterior edge of CB as delineated by transillumination. The difference in the CBD between groups was correlated with the axial length, corneal thickness, and corneal diameter.

Results: CBD was measured in 15 eyes in the PCG and control groups. The mean CBD (1.6 ± 0.4 mm) in the PCG group was significantly greater than that in the control group (1.3 ± 0.3 mm) ($p < 0.001$). The mean difference in the CBD of 2 groups was 0.33 mm (95% CI 0.15–0.54). In PCG eyes, the CBD was farthest in the superior quadrant (1.7 mm) followed by inferior (1.6 mm), temporal (1.6 mm), and nasal (1.5 mm) quadrants. The variability in CBD between quadrants in PCG eyes was greater than that in the control group. CBD in the PCG group showed a significant correlation with increasing axial length ($p = 0.05$), corneal thickness ($p < 0.001$), and corneal diameter ($p = 0.0002$).

Conclusions: The CBD from the limbus was greater in PCG eyes compared to the controls and varied significantly in different quadrants. The knowledge regarding the greater CBD and its variability in PCG eyes could enable better planning of surgical treatment in congenital glaucoma.

The location of the ciliary body (CB) in relation to the limbus (CB distance, CBD) is variable in adults.[1] However, the CBD in children, which is likely to be different from that in adults considering the size and growth of the eye, remains unexplored.

An understanding of the position of the CB in relationship to the corneo-scleral limbus (CBD) is especially important in children with primary congenital glaucoma (PCG) because the eyeball is enlarged and may result in a change in CBD.

An understanding of the position of the CB becomes important, as normal anatomical landmarks are likely to change. Such changes in anatomy potentially influence dissection techniques in various penetrating and non-penetrating procedures for pediatric glaucoma. In addition, identification of the CB is important for procedures such as trans-scleral contact diode laser cyclophotocoagulation, which is a procedure used to treat some patients with refractory PCG.[2,3] To maximize the effect of cyclophotocoagulation, the laser probe must be accurately placed over the CB. In view of the distorted anatomy of the limbus due to globe stretching, application of the G probe in its conventional location is unlikely to provide accurate laser delivery to the CB. It is therefore important to understand the CB location in the normal pediatric eyes and its altered position in eyes of children with PCG.[4]

This study was designed to determine the location of the CB in relation to the corneo-scleral limbus in normal eyes, examine differences between normal eyes and eyes of age-matched children with PCG, and review factors that might influence the CBD.

Methods

This cross-sectional study was approved by the Institutional Research Board of King Khaled Eye Specialist Hospital, Riyadh, Saudi Arabia. The study population included children examined or treated under sedation/anaesthesia at our institution. Written informed consent was obtained from parents before the study. In the PCG group, the worse eye of a child with bilateral PCG and the affected eye in children with unilateral PCG were included in this study. For comparison, we selected the normal eyes of children with unilateral ocular morbidities without glaucoma (control group).

We hypothesized that the distance between the anatomical limbus and the anterior boundary of ciliary body (CBD) in eyes with PCG was greater than that of a normal healthy eye. To test a one-sided hypothesis, we assumed that 95% of children with PCG will have a greater distance between CB and anatomical limbus. In normal healthy eyes of children, we presumed that this variation in CBD would occur in less than 40% of the eyes based on a

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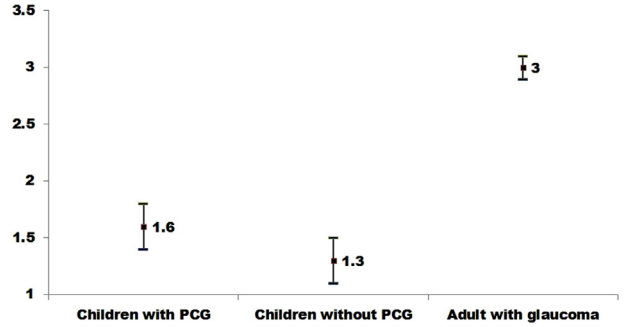

Fig. 1—Comparison of ciliary body location in eyes of children with and without primary congenital glaucoma and in adult eyes with glaucoma. *X* axis displays 3 groups; eyes of children with PCG and eyes of children without PCG and adult eyes with glaucoma from historical data.[5] *Y* axis shows distance of anterior edge of ciliary body from limbus (mm).

study that measured CB size in autopsy eyes.[5] To achieve 95% confidence interval (CI) and 95% power, we determined that the CBD should be measured in 13 eyes with PCG and 13 normal eyes. To compensate for the variation in measurement due to non-cooperation of sedated children, the sample size was increased to 15 eyes in each group.

Two ophthalmologists performed the measurements on separate patients. Measurements were made before commencement of the surgical procedure, while the children were anesthetized or sedated. The 2 ophthalmologists who took the measurements were not masked.

The ophthalmologist used standard operation room calipers to measure the distance between the corneoscleral limbus and anterior edge of the ciliary body (CBD) using a trans-illuminator with an optical fibre light source to identify the anterior edge of the CB. The unit of measurement with this caliper was 1 mm. A standard calibrated metal ruler was used to confirm the accuracy of the caliper before measurement in each patient. Two measurements were taken at each location to confirm the readings and a third or fourth one till 2 concurrent measurements matched. The anterior border of the CB was identified by the anterior edge of dark shadow seen on globe during trans-illumination. Measurements between the limbus and the anterior edge of the CB were performed in the superior (12 o'clock), inferior (6 o'clock), nasal (3 o'clock for left eye or 9 o'clock for right eye), and temporal (9 o'clock for left eye or 3 o'clock for right eye) quadrants. The measurements were recorded in millimetres.

The age, sex, eye involved, and the presence of comorbidities in the fellow eye were noted. The axial length of eyeball was measured using a contact A-scan ultrasonography (CineScan S; Quantel Medical, Cournon-d'Auvergne, France). The central corneal thickness (CCT) was measured with Corneo-Gage Plus (Sonogage Inc, Cleveland, OH). The corneal diameter was measured with the same calipers.

The data were collected on a Microsoft Excel (Microsoft Corp, Redmond, WA) spread sheet and analyzed using the Statistical Package for the Social Sciences (SPSS version 16; IBM Corp, Armonk, NY). Univariate analysis using a parametric method was performed. The CBD in the PCG group and control group were plotted separately to confirm its normal distribution followed by calculating the mean and standard deviation. To compare the CBD in eyes with PCG and the control groups, the difference of mean and the 95% CI were calculated. The influence of age, sex, and laterality of PCG on the outcome variable was evaluated using a linear regression model. The association of the axial length and CCT to the CBD was evaluated with bivariate correlation analysis.

Results

We included 1 affected eye of 15 children with PCG and 15 normal eyes of children without PCG (control group) (normal fellow eye of a child diagnosed with monocular cataract, monocular aphakia, or the fixing eye in a patient the strabismus in other eye). The demographics and other data for participants of both groups are presented in Table 1.

The variability in the distance of the anterior edge of the CB from the limbus in PCG eyes had standard error of mean of 0.09 mm, variance 0.1 mm, and range

Table 1—Demographics and diagnosis of children with and without primary congenital glaucoma

		Children with PCG (n = 15)		Children without PCG (n = 15)		
		Number	Percentage	Number	Percentage	Validation, *p*
Sex	Males	5	33.3	6	40	0.7
	Females	10	66.7	9	60	
Eye	Right	10	33.3	11	73.3	0.7
	Left	5	66.7	4	26.7	
Diagnosis	PCG	15	100	0	0	
	Cong cataract	0	0	7	46.7	
	Aphakia	0	0	2	13.3	
	Strabismus	0	0	6	40.0	
Age (months)	Median	4		31		<0.04
	25% quartile	2		1		
	Minimum	1		3		
	Maximum	54		54		

PCG, primary congenital glaucoma.