Primary congenital glaucoma (PCG; gene symbol, GLC3) is a group of disorders characterised by an improper development of the eye’s aqueous outflow system. PCG is detected clinically in neonates and infants by the increased intraocular pressure (IOP). Because the coating of the infantile eye is elastic, it stretches in response to the elevated IOP, resulting in an enlarged globe (buphthalmos).¹ ² ³

PCG is inherited as an autosomal recessive trait, and the incidence varies geographically; one in 5000 to one in 22 000 newborns in Western countries, one in 2500 in the Middle East, and one in 1250 in the gipsy population of Slovakia, among whom PCG is the major cause of blindness.¹ ⁴ In Japan, the incidence of PCG has not been determined, but most cases are sporadic.⁵

Two PCG mutation loci have been identified—the GLC3A locus which maps to chromosome 2p21⁶ ⁷ and the GLC3B locus which maps to chromosome 1p36.⁸ ⁹ Recently, several mutations in the cytochrome P4501B1 gene, CYP1B1, have been reported in families with PCG linked to the GLC3A locus.¹ ³ ⁴ ¹⁰ ¹¹ CYP1B1 gene mutations were detected in over 85% of families with PCG in Saudi Arabia, Turkey, and Slovakia.¹ ³ ⁴ ¹⁰ ¹¹ Recently, we screened the CYP1B1 gene in 65 unrelated Japanese probands with PCG and identified 11 novel mutations in 13 probands (20%).¹ ³

We present a more detailed investigation of the relation between the phenotype of Japanese patients with PCG and the genotype of CYP1B1 mutation.

SUBJECTS AND METHODS

Blood samples were collected from 66 patients (65 families) with PCG at the following hospitals: 28 at Keio University Hospital, 16 at Tokyo University Hospital, 15 at the National Children’s Hospital, three at Kyoto University Hospital, and four at Tenri Yorozu Hospital. Patients with elevated IOP associated with other ocular or systemic anomalies were excluded. None of these Japanese probands was the offspring of a consanguineous marriage. All cases except for one pair of twin girls (cases 8 and 9) in the group with mutations appeared to be sporadic with no family history of glaucoma. Informed consent was obtained from the parents of each child as well as their own participation in the study. This investigation was performed according to the guidelines of the Declaration of Helsinki.

Genomic DNA was prepared from leucocytes by proteinase K-phenol-chloroform extraction. We first screened the CYP1B1 gene (GenBank accession number U56438) by polymerase chain reaction (PCR) amplification followed by single strand conformation polymorphism (SSCP) analysis as described previously.⁷

Clinical features at initial presentation

The clinical features at the onset of PCG were ascertained in 32 cases by examining the clinical records at each hospital. Of the 32 PCG patients, 11 had a CYP1B1 mutation in both alleles (the “mutation group”), while 21 had no mutation (the “no mutation” group). We compared the mutation group with the no mutation group in terms of sex, age at diagnosis of PCG, and gonioscopic appearance. For analysis, the onset of PCG was defined as the time of the initial diagnosis.

RESULTS

All cases in the mutation and no mutation group had typical symptoms and signs of PCG such as tearing, photophobia, and corneal enlargement. The clinical and genetic information of the 11 patients with CYP1B1 mutations is summarised in Table 1.

The male:female ratio was 6:5 in the mutation group and 19:2 in the no mutation group. Both of these differences were statistically significant.

Conclusions: In clinically diagnosed cases of PCG, a subgroup shows a CYP1B1 gene mutation. Age at onset was earlier in PCG patients with CYP1B1 mutations than in patients without mutations. Women were more prevalent among patients with mutations than those without mutations.
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Tokyo University Hospital as newborns for evaluation of corneal opacities in both eyes. Both cases were affected bilaterally with PCG, and the increased IOP was detected within 1 week of age. The IOPs were elevated in both eyes, and clinical features such as corneal opacities and Gonioscopic appearance were very similar in the twins. Goniotomies were performed on both eyes of the twin. But the IOPs could not be controlled on the left eye of case 9, and finally Scheie's scleroperformation was performed after two goniotomies. The final corrected visual acuity was 0.8 for right eye and 0.7 for left eye in case 8, and 0.1 for right eye and no perception of light for left eye in case 9.

**DISCUSSION**

The rarity of PCG and its differing frequency among ethnic groups impedes analysis of the phenotype and genotype of CYP1B1 mutations. We are not aware of a previous report discussing the phenotypes of patients with and without CYP1B1 mutations. In our Japanese patients with PCG, 11 cases had a CYP1B1 mutation in both alleles and 23 cases did not have a mutation in the CYP1B1 gene.

CYP1B1 gene mutations have been identified in over 85% of PCG affected families in Saudi Arabia, Turkey, and Slovakia. However, a 27% prevalence of CYP1B1 mutation has been reported in cases with sporadic occurrence. This finding is similar to that of our earlier study, in which a 20% mutation rate was found in the Japanese PCG patients.

In our present investigation, comparisons between the CYP1B1 mutation group and the no mutation group revealed significant differences in sex preponderance and age at glaucoma onset. Interestingly, 10 cases in the mutation group, all except case 11, had bilateral involvement, and the first signs of disease appeared within 2 months of birth. In addition, compared to the no mutation group, the proportion of female patients was significantly higher in the mutation group. These features such as sex preponderance and bilateral incidence were very similar to PCG patients with the CYP1B1 mutations in Saudi Arabia, Turkey, and India. It is not clear why the sex ratios are so different between the two groups, as opposed to the fact that males account for approximately 65% of PCG cases overall. We suggest that there may be another subtype of PCG with a higher preponderance in females.

Maldevelopment of the anterior segment may involve the trabecular meshwork alone or the trabecular meshwork in combination with the iris and/or cornea. Although PCG is a specific term referring to eyes that have an isolated maldevelopment of the trabecular meshwork without other ocular developmental anomalies or diseases that can raise the IOP, the terminology for glaucomas affecting infants has been inconsistent and sometimes confusing. In our case 4, a unique uveal ectropion was observed in one of the affected eyes. Thus, a new classification of glaucomas affecting infants might be based on the presence or absence of a CYP1B1 gene mutation.

A male patient (case 11), who was a compound heterozygote with both C3130T and Val320Leu alterations, was diagnosed relatively late in life as having unilateral glaucoma. In this case, the initial signs of glaucoma were very similar to that of our earlier study, in which a 20% incidence were very similar to PCG patients with the CYP1B1 gene mutation in both alleles and 23 cases did not have a mutation in the CYP1B1 gene. The initial signs of disease appeared within 2 months of birth. In this case, the initial signs of glaucoma were identified when a 20% incidence were very similar to PCG patients with the CYP1B1 gene mutation in both alleles and 23 cases did not have a mutation in the CYP1B1 gene.

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We had also a pair of identical twin girls with the CYP1B1 gene mutation (cases 8 and 9). There was a concordance in the phenotypic features due to the same genetic factor, but the final visual acuity was different for the two cases. Although we should consider both the surgical efficacy and the influence of amblyopia, some environmental factors as well as genetic factors might modulate the severity of the disease.

In conclusion, among Japanese patients clinically diagnosed with PCG, we found a subtype with CYP1B1 gene mutations. Clarification of how the CYP1B1 gene is related to anterior chamber development may lead to better understanding of the mechanism of PCG occurrence and fundamental changes in the treatment of PCG.

**REFERENCES**