Retinal dystrophies caused by mutations in RPE65: assessment of visual functions

Christian P Hamel, Jean-Michel Griffon, Laetitia Lasquellec, Christian Bazalgette, Bernard Arnaud

Abstract

Aims—To characterise the disease in patients with mutations in RPE65.

Methods—Individuals from two families were studied clinically.

Results—13 and 20 year old compound heterozygote individuals from one family with R234X and 1121delA mutations showed nystagmus, macular dystrophy and low contrasted spots in the fundus. Some heterozygotes had macular drusen. A 40 year old compound heterozygote individual from another family with L22P and H68Y mutations had few bone spicule pigment deposits and macular atrophy.

Conclusion—Compound heterozygote individuals had severe rod-cone dystrophies featuring few pigment deposits in the fundus, pigment epithelium atrophy, and early involvement of the macula, with variations in severity leading to the diagnosis of Leber’s congenital amaurosis or retinitis pigmentosa. Macular drusen in heterozygotes carrying a null allele may reflect the decreased capacity in the RPE65 function.

Recently, genetic defects in RPE65, the gene coding the retinal pigment epithelium (RPE) specific protein RPE65, have been found.1–6 There is evidence indicating that RPE65 is involved in the isomerisation from all-trans to 11-cis retinol that occurs in the RPE.7 Here, we describe the observations of three compound heterozygote individuals and of their relatives (heterozygotes and normal homozygotes) carrying RPE65 mutations.

Patients and methods

Patients

In the three generation French family 1, 15 members, except II-1, were examined; in the two generation Italian family 2, only the propositus (II-2) was examined (Fig 1). Results of the RPE65 screening in both families has been reported previously.1–4

Methods

Standard ophthalmological examination was performed as well as colour vision testing, Goldmann perimetry, and fluorescein angiography. Full field electroretinogram (ERG) was recorded using a ganzfeld apparatus (Metrovision, France) and dark adaptometry was performed with a Goldmann-Weekers apparatus using a test seen with an angle of 11° according to the standard protocol.

Results

Patients with mutations in both RPE65 alleles (compound heterozygotes)

A 20 year old patient (III-2) from family 1 had nystagmus, night blindness, and inability to move alone since birth in the absence of systemic disease; her condition was reported as

Family 1

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Family 2

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Leber's congenital amaurosis. She was emmetropic with 4/200 and 2/200 in right and left eyes, respectively. She showed numerous yellowish spots throughout the fundus, narrowing of retinal vessels, moderate pallor of the optic discs, and macular atrophy (Fig 2A, B). She could not discriminate any colour. Photopic and scotopic ERGs were unrecordable. Her 13 year old brother (III-3) showed a similar ocular history and symptoms, although he seemed to be slightly less severely affected (Fig 2C, D).

Patient II-2 from family 2, aged 40, had a medical history of retinitis pigmentosa. Although he reported night blindness since early childhood, he had no difficulty moving in daytime, and was reading fluently until aged 13. He had visual acuity of 6/200 with −2.00/−2.00 at 10° and 8/200 with −1.50/−1.25 at.
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Figure 3 Right eye of 47 year old individual II-7 who is heterozygote (1121delA+/) shows many small macular drusen.

130° in right and left eyes, respectively. Fundus examination showed markedly attenuated retinal vessels, waxy pallor of optic discs, rather sparse bone spicule-shaped pigment deposits in midperiphery, and extended atrophy of the macula with patches of retinal pigment epithelium/choriocapillaris atrophy (Fig 2E, F). Tritanopia and restriction of the V4e isopter in each eye were also noted. ERG rod responses were undetectable.

HETEROZYGOTE INDIVIDUALS

Individuals with the R234X/+ genotype were unremarkable except for a few small macular drusen in I-1 who also had slightly diminished ERG rod responses. Dark adaptometry was within the normal range.

Six individuals carried the 1121delA/+ genotype. In the two heterozygotes from the first generation (I-3 and I-4), there were obvious signs of AMD with many large, soft drusen. By contrast, their normal homozygote sister (I-2) had no soft macular drusen. All three heterozygotes from the second generation had small macular drusen (Fig 3) with ERG rod responses slightly diminished in two of them (II-3 and II-5). Their normal homozygote (I121delA/+) shows many small macular drusen.

Discussion

In patients with Leber's congenital amaurosis (LCA), visual acuity was still measurable, a finding consistent with the normal visual outcome of RPE65 gene mutations in only five unrelated cases, while more than 30 unrelated patients have been diagnosed as LCA1, LCA2, or CSRD. Published cases of LCA and CSRD show that patients carry either translation terminating or missense mutations on both alleles, suggesting that in most cases a severe disease occurs, whatever the modification of the RPE65 protein (absence, truncation, or change in amino acid).

Mutations in other RPE expressed genes involved in the retinol metabolism have been described including RLBP1, encoding cellular retinaldehyde binding protein (CRALBP), causing severe retinitis pigmentosa, retinitis punctata albescens, and Bothnia dystrophy, and RDH5 encoding 11-cis retinol dehydrogenase, that leads to fundus albipunctatus. These conditions and those due to RPE65 mutations are characterised by night blindness, few or no pigment deposits, absence of pigment epithelium atrophy, involvement of the macula, and often dot-like deposits in the fundus. These features are also quite similar to vitamin A deprived retinal dysfunction syndrome and to hereditary defect in retinol binding protein, suggesting that impairment in the ocular metabolism of retinol predominantly affects rods. Macular involvement may reflect the greater density of rods over cones at the periphery of the macula.

We noted the presence of small macular drusen in individuals heterozygous for the 1121delA mutation, as found in heterozygous carriers with TULPI translation terminating mutations that cause early onset severe retinal degeneration in the homozygous state. The presence of these drusen suggests that mutation in one allele may indeed cause a moderate dysfunction in the outer retina and lead to a time dependent accumulation of materials.

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