Short Report

Germline mosaicism in Rett syndrome identified by prenatal diagnosis


Rett syndrome is an X-linked neurodevelopmental dominant disorder that affects almost exclusively girls. The vast majority of cases are sporadic and are caused by de novo mutations in the MECP2 gene, located in Xq28. Only few familial cases have been reported: in four cases, the mother was an asymptomatic carrier and in other four cases, the germline mosaicism in the mother was postulated. Owing to the above reported cases of germline mosaicism, we decided to offer prenatal diagnosis to all expectant mothers with a Rett daughter despite the absence of the causative mutation in parents’ blood. We describe here the outcome of the first nine cases of prenatal diagnosis followed by our center. In eight cases, the fetus did not carry the mutation. In one case, the female fetus did carry the same mutation of the affected sister. The couple decided to interrupt the pregnancy and to devolve fetal tissues for research purposes. Our results indicate that prenatal diagnosis should be proposed to all couples with a Rett daughter, even when the mutation is apparently de novo. Moreover, one positive prenatal test among the first nine cases indicates that germline mosaicism may be seriously considered for the assessment of recurrence risk during genetic counseling.

As soon as the gene responsible for Rett syndrome (RTT) was discovered, we started performing molecular analysis of MECP2 gene in the RTT females who were admitted to the Child Neuropsychiatry of the University of Siena (1). We also started to collect parents’ samples in order to verify whether the mutation was de novo or inherited. In 115 apparently sporadic cases diagnosed from 1999 till today, the mutation was not found in parents’ DNA except for one case where the same MECP2 mutation was found in both a RTT girl and her unaffected mother (unpublished data). As germline mosaicism was reported in RTT, we decided to offer prenatal diagnosis in case of a second pregnancy of the above reported couples even with a de novo mutation. This suggestion was clearly stated in the counseling report. During the last 4 years, nine couples decided to have a pregnancy and accepted the suggestion to perform a prenatal diagnosis. These nine prenatal diagnoses were performed by chorionic villous sampling in five cases and by amniocentesis in the other four. In eight cases, the fetus DNA was normal and pregnancies were successfully delivered. Five girls and three boys were born and every child, aged from 6 months to 4 years, is presently healthy. In one case, we detected in the fetus the same MECP2 mutation of the affected sister (Table 1).

Case report

We first met the family for genetic counseling during an hospitalization of the affected daughter in the Child Neuropsychiatry, University of Siena...
The proband (No. 709) is the second child of non-consanguineous parents and she was 3 years old at the time of the counseling. She had a normal development in the first 6 months. Then her progress ceased. The ability to use her hands was overwhelmed by incessant hand stereotypes, and hyperventilation and groundless smiles were referred. At 3 years of age, she still had lallation and she was not able to walk. Her head circumference was 45 cm (<3rd cent). She fulfilled the criteria for RTT (2). As a collateral finding, sarcosin, which is not normally detectable in urine and plasma, was detected in this patient in both urine (6.53–9.66 mmol/l) and plasma (0.16–0.17 mmol/l).

We offered a molecular analysis of MECP2 gene to the family. Blood was collected from the proband and her parents after informed consent. The genomic DNA was extracted and coding exons 2–4 of MECP2 gene were amplified and directly sequenced. In the DNA of the proband, the c.567-568insA mutation was found in heterozygous state. Either of the parents did not carry the mutation and there was no evidence of low-grade mosaicism by denaturing high performance liquid chromatography (DHPLC) analysis (Fig. 1b). The suggestion for prenatal diagnosis in case of a future pregnancy was clearly stated during the second session of genetic counseling together with the explanation of the molecular results.

One year after the genetic counseling, the parents, 38 years old each, decided to have a third pregnancy and asked for prenatal diagnosis. The couple decided to go through chorionic villous sampling at 13 weeks + 5 days of gestation. The extracted DNA was analyzed for the presence of the c.567-568insA mutation by DHPLC and direct sequencing. The DNA of the female fetus was found to have the same mutation of the RTT sister (Fig. 1b). In agreement with the couple, we decided to repeat the analysis on a second chorionic villous sampling on the sixteenth week of gestation. The result was confirmed and the couple decided to abort the fetus on the seventeenth week + 1 day of gestation. The fetus was aborted through prostaglandin induction. On the DNA extracted from the umbilical cord, we again confirmed the presence of the c.567-568insA mutation (data not shown).

The whole fetus was devolved to our institute for research purposes. We collected samples from different areas of the brain and from other organs (thymus, liver, spleen, placenta, kidneys, heart, adrenal glands, lung, esophagus, stomach, intestine, and pancreas) for tissue culture, molecular biology tests,
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and histological analysis. Morphological analysis of the brain showed a normal picture. However, the detection of subtle differences in the architectural pattern should require a comparison with a fetus of the same gestational age. This control sample is difficult to obtain, as in voluntary abortion usually pregnancy is interrupted in an earlier gestational age.

Discussion

Rett syndrome is an X-linked neurodevelopmental dominant disorder that affects almost exclusively girls. The vast majority of cases is sporadic and is caused by de novo mutations in MECP2 gene. Only few familial cases, with a documented MECP2 mutation, have been reported. For some of them, the explanation resides in the fact that the mother is an asymptomatic carrier (3–6). In other cases, four in all, germline mosaicism in the mother was postulated. Wan et al. (3) reported of a woman with motor-coordination problems and mild learning disabilities, her RTT sister, her RTT daughter, and her son who died of encephalopathy. All the four individuals carried the same MECP2 mutation. Her parents did not carry the mutation suggesting germline mosaicism (3, 4). In 1999, Amir et al. (7) reported of two half sisters with clinical and molecular diagnosis of RTT. The mutation was not present in their mother suggesting germline mosaicism. Another identical case was reported by Villard et al. (8). Yaron et al. reported of a RTT girl and her brother with severe neonatal encephalopathy, carrying the same MECP2 mutation. The asymptomatic mother did not carry the mutation (9).

In the four familial cases reported above, the MECP2 mutation was maternally derived. Trappe et al. observed that in sporadic cases of RTT, the origin of the MECP2 mutation was almost exclusively paternal (10). Yaron et al. state that we should be more careful in defining a risk of recurrence in those cases where the mutation is maternally derived (9). In order to strengthen this hypothesis, it would have been useful to establish the origin of MECP2 mutation in our case. Unfortunately, in our family the MECP2 mutation origin could not be derived.

So far, expression studies in human tissues have used adult RTT brain only (11). The availability of this fetal brain will allow us to study MECP2 expression, its localization, and gene-expression profiling in a particular developmental stage. Furthermore, this material will allow us to study the possible effects of MECP2 absence on brain structure and on neuronal morphology and plasticity.

This is the first reported case of mosaicism found after a prenatal diagnosis. The frequency of germline mosaicism in RTT is at present unknown. The small number of cases (nine) does not allow to derive a correct percentage (1/9 = 11%) useful for genetic counseling. However, taking into account our experience, mosaicism should not be considered so rare. Despite the fact that the precise rate of germline mosaicism of MECP2 mutations remains unknown, our results strongly indicate that the opportunity to perform a prenatal diagnosis should be discussed with all couples with a RTT daughter despite the apparently de novo mutation.

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References