Uniparental disomy

Uniparental disomy (UPD) is defined as the presence of two homologous chromosomes (or parts thereof) that originate **from the same parent**. Uniparental disomy has been described, for example, in some patients with **Prader-Willi syndrome** (maternal UPD - both chromosomes 15 come from the mother) and **Angelman syndrome** (paternal UPD - both chromosomes 15 from the father), in some patients with **Beckwith Wiedemann syndrome** (paternal UPD chromosome 11), in a patient with cystic fibrosis and short stature (maternal UPD of chromosome 7).

Mechanisms of UPD formation

There are several mechanisms by which UPD can arise. Probably the most common is the **loss** of one chromosome from a **trisomic zygote** (correction using **Anaphase lag**), when the chromosome that is represented once in terms of parental origin is lost.

Proof of this mechanism is the finding of mosaic trisomy 15 during prenatal examination of chorionic villus cells. A repeated examination of fetal cells (amniotic cells) showed a normal karyotype, and the child was diagnosed with Prader-Willi syndrome with maternal UPD.

Another proof of the existence of this mechanism is the described unusual **transmission of haemophilia from father to son**, when a zygote with XXY chromosomes had to be formed and then the loss of the maternal X chromosome, or the transmission of the homologous translocation 22/22 from parent to child in a balanced form, when trisomic zygotes lost a free 22nd chromosome. Evidence of the loss of a chromosome from a trisomic zygote is also the older age of the parents in children with UPD.

Another possible mechanism is gametic complementation (fusion of a disomic and nullisomic gamete – both resulting from nondisjunction), chromosome duplication of a monosomic zygote, or a postfertilization error, when postzygotic nondisjunction and subsequent chromosome duplication or mitotic recombination occur.

Relation to imprinting

🔎 *For more information see Gene imprinting, Gene imprinting and human pathology.*

Uniparental disomy is one of the proofs of the existence of **imprinted genes** – genes, that have only one active allele, namely the allele of a certain parental origin. If imprinted genes did not exist, UPD would most likely be without clinical manifestations, and apparently many UPD chromosomes that do not have imprinted genes remain unrecognized.

Consequences of UPD

Clinical manifestations of UPD of those chromosomes that carry imprinted genes are associated with the **lack of function of active alleles** (Prader-Willi and Angelman syndromes), ev. with excess function of active alleles (Beckwith-Wiedemann syndrome) in UPD. Another consequence is the possibility of homozygosity of recessive alleles, as was the case with a patient with cystic fibrosis and short stature, whose mother was a carrier of the mutation.

The existence of UPD demonstrates that normal development **requires the complementary action** of both parental sets of chromosomes. In a situation where this condition is not met, developmental disorders occur even with a numerically and structurally completely normal karyotype, because an important mechanism of **gene expression regulation**, which is gene imprinting, is **disrupted**.

Similar situations where the presence of all chromosomes from one parent is involved are in **ovarian teratoma**, a benign tumor that arises from the parthenogenetic division of an unfertilized egg and therefore only maternal chromosomes are present or in **complete hydatidiform mole** (trophoblast hyperplasia without the presence of fetal tissues with the risk of choriocarcinoma), which arises from the fertilization of an enucleated egg by sperm whose chromosomes are duplicated, or from the dispersion of an enucleated egg, only the paternal genome is present. The cause of these pathologies is also an imprinting disorder.

Links

Related articles

- Gene imprinting
- Gene imprinting and human pathology
- Angelman syndrome
- Prader-Willi syndrome
- Beckwith-Wiedemann syndrome

References

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