Chromosome 14

Subjects: Genetics & Heredity

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Humans normally have 46 chromosomes in each cell, divided into 23 pairs. Two copies of chromosome 14, one copy inherited from each parent, form one of the pairs.

chromosomes & mtDNA

1. Introduction

Chromosome 14 spans more than 107 million DNA building blocks (base pairs) and represents about 3.5 percent of the total DNA in cells.

Identifying genes on each chromosome is an active area of genetic research. Because researchers use different approaches to predict the number of genes on each chromosome, the estimated number of genes varies. Chromosome 14 likely contains 800 to 900 genes that provide instructions for making proteins. These proteins perform a variety of different roles in the body.

2. Health Conditions Related to Chromosomal Changes

2.1. FOXG1 syndrome

A deletion of genetic material from part of the long (q) arm of chromosome 14 can cause *FOXG1* syndrome, which is a rare disorder characterized by impaired development and structural brain abnormalities. The region of chromosome 14 that is deleted includes the *FOXG1* gene as well as several neighboring genes. Depending on which genes are involved, affected individuals may have additional signs and symptoms, including distinctive facial features and a missing connection between the left and right halves of the brain (a structure called the corpus callosum).

The protein normally produced from the *FOXG1* gene plays an important role in brain development before birth, particularly in a region of the embryonic brain known as the telencephalon. The telencephalon ultimately develops into several critical structures, including the largest part of the brain (the cerebrum), which controls most voluntary activity, language, sensory perception, learning, and memory. A loss of the *FOXG1* gene disrupts normal brain development starting before birth, which appears to underlie the structural brain abnormalities and severe developmental problems characteristic of *FOXG1* syndrome. It is unclear how the loss of additional genes contributes to the signs and symptoms of the condition.

2.2. Multiple myeloma

A rearrangement (translocation) that moves genetic material from one of several other chromosomes to a region of chromosome 14 called 14q32 occurs in 20 to 60 percent of cases of multiple myeloma, which is a cancer arising from plasma cells, a type of white blood cell. The translocation is somatic, which means it is acquired during a person's lifetime and is present only in certain cells. The translocation likely affects genes that play a critical role in regulating cell division by preventing cells from dividing too rapidly or in an uncontrolled way. Disruption of these genes may interfere with proper control (regulation) of cell growth and division (proliferation), resulting in the excessive proliferation of plasma cells that characterizes multiple myeloma.

2.3. Ring chromosome 14 syndrome

Ring chromosome 14 syndrome is caused by a chromosomal abnormality known as a ring chromosome 14 or r(14). A ring chromosome is a circular structure that occurs when a chromosome breaks in two places and its broken ends fuse together. People with ring chromosome 14 syndrome have one copy of this abnormal chromosome in some or all of their cells.

Researchers believe that several critical genes near the end of the long (q) arm of chromosome 14 are lost when the ring chromosome forms. The loss of these genes is likely responsible for several of the major features of ring chromosome 14 syndrome, including intellectual disability and delayed development. Researchers are still working to determine which missing genes contribute to the signs and symptoms of this disorder.

Epilepsy is a common feature of ring chromosome syndromes, including ring chromosome 14. There may be something about the ring structure itself that causes epilepsy. Seizures may occur because certain genes on the ring chromosome 14 are less active than those on the normal chromosome 14. Alternately, seizures might result from instability of the ring chromosome in some cells.

2.4. Other chromosomal conditions

A rare condition known as terminal deletion 14 syndrome causes signs and symptoms similar to those of ring chromosome 14 syndrome. Terminal deletion 14 syndrome is caused by the loss of several genes at the end (terminus) of the long (q) arm of chromosome 14. In addition, some people with terminal deletion 14 syndrome have a loss or gain of genetic material from another chromosome. People with this condition may have weak muscle tone (hypotonia), a small head (microcephaly), frequent respiratory infections, developmental delay, and learning difficulties.

Other changes in the number or structure of chromosome 14 can have a variety of effects, including delayed growth and development, distinctive facial features, and other health problems. Several different changes involving chromosome 14 have been reported. These include an extra copy of a segment of chromosome 14 in every cell (partial trisomy 14), an extra copy of the entire chromosome in only some of the body's cells (mosaic trisomy 14),

and deletions or duplications of part of chromosome 14. Full trisomy 14, an extra copy of the entire chromosome 14 in all of the body's cells, is not compatible with life.

Health problems can also result from a chromosome abnormality called uniparental disomy (UPD). UPD occurs when people inherit both copies of a chromosome from one parent instead of one copy from each parent. The long arm of chromosome 14 contains some genes that are active only when inherited from the mother, and other genes that are active only when inherited from the father. Therefore, people who have two paternal copies or two maternal copies of chromosome 14 are missing some functional genes and have an extra copy of others.

When both copies of chromosome 14 are inherited from the mother, the phenomenon is known as maternal UPD 14. Maternal UPD 14 is associated with premature birth, slow growth before and after birth, short stature, developmental delay, small hands and feet, and early onset of puberty. When both copies of the chromosome are inherited from the father, the phenomenon is known as paternal UPD 14. Paternal UPD 14 is associated with an excess of amniotic fluid (which surrounds the baby before birth); an opening in the wall of the abdomen; distinctive facial features; a small, bell-shaped chest with short ribs; and developmental delay. Both maternal UPD 14 and paternal UPD 14 appear to be rare.

2.5. Other cancers

Translocations of genetic material between chromosome 14 and other chromosomes have been associated with several types of cancer. Studies show that these translocations disrupt genes that are critical for keeping cell growth and division under control. Unregulated cell division can lead to the development of cancer.

Translocations involving chromosome 14 have been found in cancers of blood-forming cells (leukemias), cancers of immune system cells (lymphomas), and several related diseases. For example, Burkitt lymphoma, a cancer of white blood cells that occurs most often in children and young adults, is related to a translocation between chromosomes 8 and 14. Another type of lymphoma, called follicular lymphoma, is often associated with a translocation between chromosomes 14 and 18.

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