

[Autism and Cancer: How Research Shows a Correlation Between Cancer and Autism Genes]

Author: Logan Heausler

Major: Biology Pre-Med

Department of Microbiology and Molecular Genetics, Oklahoma State University, Stillwater, OK 74078, USA

Key Words:

Autism, cancer, risk genes, PTEN

Abstract

Tumor suppressor genes are genes that control cell growth, in some cases mutations can occur that lead to cancer. Autism is a neurological disorder that develops repetitive behaviors, in which the cerebral cortex has been affected. The article explains risks and factors of the corresponding relationship of autism and cancer genes and how it relates to tumor suppressor genes and cancer growth. Recent studies have found an overlap of genes from cancer and autism acknowledging the findings of malignant tumor growth in various parts of the body. The relation of tumor suppressor genes, oncogenes, chromosome 8p correspond to the development of cancer and autism. Showing alternative research exemplifying how age correlates with cancer and autism and why researchers have developed a new understanding for this topic.

Introduction

Autism is a neurodevelopmental condition which stems from a wide range of multiple neurological differences. One of the most common is a genetic condition. Becoming apparent around the age of 3, autism is diagnosed behaviorally and socially with communication deficiencies, repetitive behaviors and interests, and difficulty learning or paying attention. Autism is a monogenetic disease defined as a mutated singular gene that was inherited. Genes are the determining factor as to how our cells make proteins. In cancer these genes contain a mutation that causes them to malfunction leading to rapid growth and cell division. Through research it has been proven that there is a correlation between cancer and autism genes. These genes, known as risk genes, share common characteristics when compared to each other. The correspondence doesn't reflect how the risk genes arise, but the functions they contain in each condition. The risk genes found in autism are tumor suppressor and oncogenes. Oncogenes have a potential to cause cancer whereas tumor suppressor genes do not. The correspondence of autism and cancer genes has been under much research with some grey areas, there is still much evidence that shows how the functions in risk genes share characteristics among each other.

Discussion

Research has been ongoing in this topic for some time, trying to find answers and solutions to the findings of risk gene connections between autism and cancer. With many overlaps, answers were found studying this topic. In a recent study done by Crawley, Heyer, and LaSalle, they researched pathways and drug targets of the two conditions by sampling individuals who had autism spectrum disorder (ASD). Their findings concluded that there were 43 genes that shared specific associations with cancer genes. This opened the pathway to determining that the functions of these genes such as, transcription factors and genome maintenance would be consistent with tumorigenesis. Tumorigenesis is the process of a tumor developing. Split into three stages, initiation, progression, and metastasis, which begins when genes are mutated. Throughout the continuous developing research, there have been specific genes that have been found to have mutations with the direct relation to cancer. Deemed from the insight of signaling pathways, the control of a cell's division and growth, it was found that they included "...key proteins implicated in cell proliferation or

differentiation pathways implicated in cancer and autism...” (Crawley, Heyer, Laselle. Pg. 139). Autism is a neurological condition stemming from the brain, causing connected regions to split away from each other. The brain in this case, has an overgrowth in the cerebral and limbic structures leading to the deficiency’s that individuals experience. Concluded from the research done by Butler and others in 2005, it was suggested that the effects of autism on the brain had a higher risk for malignancy. PTEN gene mutations are found in a handful of people with autism, specifically in one-fifth of diagnosed individuals. PTEN is a tumor suppressor gene that causes tumor growth and can lead to cancer. (Cowden, Proteus, Bannayan-Riley-Ruvalcaba syndrome). “Several of these overgrowth-related disorders are also at risk of developing malignancy, particularly colorectal cancer.” (Butler et al., 2019). Colorectal cancer is caused by the overgrowth of the colon or rectal. In similarity, the PTEN gene causes problems within the pathway in which it acts as an inhibitor and causes disturbances which leads to malignancy. Finally, the findings from researchers Butler et al. and Varga et al. “...suggested that mutations serve a critical component of shared cancer and ASD etiology...” (Butler et al. 2019). Similarly with the idea that tumor suppressor genes take part in a vital connection with autism and cancer, further research has developed the idea that there is another correlation between the chromosomal 8p region and cancer as well. Chromosome 8p causes intellectual disabilities among many people including, epilepsy, autism, and other sensory processing disorders. On this specific chromosome there are 484 annotated genes which span amongst oncogenes and tumor suppressor genes. In a study conducted by Seisdedos and Rubenstein, “...21 genes in this region are most likely to contribute to neuropsychiatric disorders...neurodegenerative disorders, and cancer.” (Seidsdedos, Rubenstein, pg. 563). Among the list of neuropsychiatric disorders was autism. With these in-depth findings, evidence and studies have found numerous correspondence to not only risk gene similarities but specific genes that are mutated forming tumorous cancers, tumor suppressor genes, and genes in other regions of the body. Although there is more research that is needed to be done to find the direct relationship between the two disorders, there has been growth in this area of study.

Conclusion

The results drawn from the research offer many conclusions that show the correlation between cancer and autism genes. These results address a variety of ways they are related to each other. For example, researchers found that oncogenes and tumor suppressor genes are commonly found amongst the individuals that are diagnosed with autism. These genes both have a potential to cause cancer, and in the study done by Cowden et al. and similarly, by Butler et al. PTEN is a tumor suppressor gene that causes an overgrowth of cells leading to colorectal cancer. To back this finding, from the Translation Psychiatry program found that, “PTEN hamartoma tumor syndrome is an example of a genetic disorder associated with a relatively high prevalence of ASD.” (Busch et al., 2019). The disorder, PTHS is the mutation found in the PTEN gene itself which was found in 20% of individuals who have autism. Although there is still some area of this specific research that needs answers. A common inference made is that because people who have been diagnosed with ASD carry similar genes with those of cancer, it is assumed that they have an increased risk of developing cancer. Though, a study done in 2010 found different findings. After taking a study group of 702 individuals with ASD the team was unable to find the expected results of childhood cancer in those with ASD. (Blatt et al.). This then led to a study done by epidemiologists who found the appearance of breast cancer resulting from the same mutated genes as those in individuals with ASD. As some research is backed by this, Blatts’ findings cause a speculation to arise. Most cancers, such as breast cancer are more commonly found in middle aged adults. Looking into the study done by Blatt and others, autism begins to develop during fetal life, but isn’t typically diagnosed until around the age of 3 or later. With this understanding and the knowledge of most cancers, research concluded in studies, developing at a much later time in life, it allows an opening for further studies to be conducted. In the article written by Crawley and others, they state “...the absolute number of cases is low, and more studies need to be conducted, particularly in adults, because cancer incidence is significantly correlated to age.” (Crawley et al., 2016). So, although conclusions have been drawn about the PTEN mutated gene leading to cancers such as breast and colorectal cancer, there is a dilemma looking into the idea of how age, specifically children, are at risk for developing cancer who have been diagnosed with ASD. Autism and cancer have some overlapping findings from gene risk factors and gene mutation functions. Lastly, chromosome 8p has also been discovered to have a correlation between autism and cancer. Typically, autism is related to a change in the copies of the HOXA1 gene that are located on gene 7. Even though this is the case it has been concluded that chromosome 8p is responsible for neurological development too. This chromosome also contains oncogenes and tumor suppressor genes that are known to be possible cancer-causing agents. Studies have concluded both sides of the research, correlations that lead to the development of cancer and ones that leave an area of question due to age and the knowledge about when both cancer and autism is developed in an individual. More research needs to be done, and questions answered, to find how childhood autism is related to cancer development.

Acknowledgments

Busch, Robyn M., S. Srivastava, O. Hogue, T. Frazier, P. Klaas, A. Hardan, J. Martinez-Agosto, M. Sahin, and C. Eng. “Neurobehavioral Phenotype of Autism Spectrum Disorder Associated with Germline Heterozygous Mutations in PTEN.” *Translational Psychiatry*, vol. 9, no. 1, 2019, pp. 1-9.

Center for Disease Control and Prevention. “What Is Autism Spectrum Disorder?” *Centers for Disease Control and Prevention*, 9 Dec. 2022.

Crawley, Jacqueline N., W. D. Heyer, and J. LaSelle. “Autism and Cancer Share Risk Genes, Pathways, and Drug Targets.” *Trends in Genetics*, vol. 32, no. 3, 2016, pp. 139–146.

Gabrielli, Alexander, A. Manzardo, M. Butler. “Geneanalytics Pathways and Profiling of Shared Autism and Cancer Genes.” *International Journal of Molecular Sciences*, vol. 20, no. 5, 2019, p. 1166.

Tabarés-Seisdedos, R, and J. L. Rubenstein. “Chromosome 8P as a Potential Hub for Developmental Neuropsychiatric Disorders: Implications for Schizophrenia, Autism and Cancer.” *Molecular Psychiatry*, vol. 14, no. 6, 2009, pp. 563–589.,

Wen, Ya, and M. Herbert. “Connecting the Dots: Overlaps between Autism and Cancer Suggest Possible Common Mechanisms Regarding Signaling Pathways Related to Metabolic Alterations.” *Medical Hypotheses*, vol. 103, 2017, pp. 118–123.,