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Immunotherapy for Brain Tumors: Current Status and Future Directions

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INTRODUCTION

Immunotherapy has emerged as a promising approach in the treatment of brain tumors, aiming to harness the body's immune system to fight cancer cells. This innovative field has shown significant advancements and offers new hope for patients with brain tumors, particularly glioblastoma multiforme the most aggressive and lethal form of brain cancer. Checkpoint inhibitors are one of the most well-known forms of immunotherapy. In brain tumors, agents like pembrolizumab and nivolumab have been explored. However, their effectiveness in GBM has been modest compared to other cancers, likely due to the unique microenvironment of brain tumors and the blood-brain barrier that limits drug delivery. Chimeric Antigen Receptor (CAR) T-cell therapy involves modifying a patient's T-cells to express a receptor specific to cancer cells.

DESCRIPTION

Oncolytic viruses selectively infect and kill cancer cells while stimulating an immune response against the tumor. DNX-2401, an engineered adenovirus, has shown encouraging results in early-phase trials for GBM, with some patients achieving long-term survival. These viruses can also be engineered to express immune-stimulatory molecules, enhancing their therapeutic effects. Despite the promising advancements, several challenges remain in the effective application of immunotherapy for brain tumors. The BBB is a major obstacle, limiting the delivery of immunotherapeutic agents to the brain. Strategies to transiently disrupt the BBB or develop agents that can cross it are under investigation. The microenvironment of brain tumors is highly immunosuppressive, characterized by regulatory T-cells, myeloid-derived suppressor cells, and other factors that inhibit immune responses. Overcoming this immunosuppression is critical for the success of immunotherapies. GBM and other brain tumors exhibit significant genetic and phenotypic heterogeneity, making it challenging to target all tumor cells with a single therapy. Combination therapies and personalized approaches are being explored to address this issue. Combining different immunotherapeutic strategies or integrating immunotherapy with traditional treatments like radiation and chemotherapy holds promise. For instance, radiation can increase the visibility of tumor cells to the immune system, potentially enhancing the effects of checkpoint inhibitors. Innovative delivery systems, such as nanoparticles and focused ultrasound, are being developed to improve the delivery of immunotherapeutic agents across the BBB. These technologies could enhance the efficacy and reduce the side effects of treatments.

CONCLUSION

Immunotherapy represents a transformative approach in the fight against brain tumors, with several promising strategies currently under investigation. While challenges remain, ongoing research and technological advancements hold the potential to significantly improve outcomes for patients with brain tumors. The future of neuro-oncology will likely see a more personalized and integrated approach, combining immunotherapy with other treatments to achieve better control and possible eradication of these devastating diseases. Engineering CAR T-cells to overcome the immunosuppressive environment of brain tumors is a promising approach. This includes designing CAR T-cells that secrete cytokines to modulate the tumor microenvironment or using gene editing techniques to enhance their efficacy.

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CONFLICT OF INTEREST

The author declares there is no conflict of interest in publishing this article.

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