Triple-negative breast cancer

see Triple-negative breast cancer intracranial metastases.

Triple-negative breast cancer (TNBC) is a subtype of breast cancer characterized by the absence of three key receptors: estrogen receptor (ER), progesterone receptor (PR), and human epidermal growth factor receptor 2 (HER2). These receptors are commonly targeted in breast cancer treatment, but TNBC lacks them, making it challenging to treat using hormone therapy or drugs that target HER2.

Here are some key features of TNBC:

Lack of Hormone Receptors: TNBC does not express estrogen or progesterone receptors. This means that hormonal therapies, such as tamoxifen or aromatase inhibitors, which are effective in hormone receptor-positive breast cancers, are not typically effective for TNBC.

HER2-Negative: TNBC is also negative for the HER2 receptor, another target in breast cancer treatment. HER2-targeted therapies like trastuzumab (Herceptin) are not effective for TNBC.

Aggressive Nature: TNBC tends to be more aggressive compared to other subtypes of breast cancer. It often has a higher rate of recurrence and metastasis, making it more challenging to treat.

Younger Age at Diagnosis: TNBC is more commonly diagnosed in younger women, and it is more prevalent in African American and Hispanic populations.

Genetic Factors: There is evidence suggesting a genetic predisposition to TNBC. Mutations in the BRCA1 gene, in particular, are associated with an increased risk of developing TNBC.

Limited Treatment Options: Due to the lack of specific receptors, the treatment options for TNBC are limited. Standard treatments often include surgery, chemotherapy, and radiation therapy. Immunotherapy is being investigated as a potential treatment avenue.

High Tumor Heterogeneity: TNBC is known for its molecular heterogeneity, meaning that the cancer cells can have different genetic characteristics within the same tumor. This heterogeneity can contribute to variations in treatment response and outcomes.

Research and Clinical Trials: Given the challenges associated with TNBC, there is ongoing research to identify new and targeted therapies. Clinical trials are essential for testing novel treatments and improving outcomes for individuals with TNBC.

Because TNBC lacks the receptors that are typically targeted in breast cancer treatment, finding effective and targeted therapies for this subtype remains a significant challenge. Research is ongoing to better understand the molecular mechanisms of TNBC and to develop new treatment strategies that take into account its unique characteristics.

Treatment

Triple-negative breast cancer (TNBC) is an aggressive, metastatic, and apparently drug-resistant subtype of breast cancer with a higher immune response compared to other types of breast cancer.

Photodynamic therapy (PDT) has been gaining popularity for its non-invasive nature, minimal side effects, and spatiotemporally controlled benefits. The use of metal-organic frameworks (MOFs) loaded with programmed death ligand 1 (iPD-L1) offers the possibility of combining PDT with immunotherapy.

Outcome

Target-specific treatment modalities are currently not available for triple-negative breast cancer (TNBC), and acquired chemotherapy resistance is a primary obstacle to the treatment of these tumors.

Experimental research studies

Liang et al. constructed PCN-224, a MOFs with good biocompatibility and biodegradability for the delivery of the PD-L1 small molecule inhibitor BMS-202 to achieve a synergistic anti-tumor strategy of PDT and immunotherapy. Hyaluronic acid (HA) modified PEG (HA-PEG) was synthesized for the outer layer modification of the nanocomplex, which prolongs its systemic circulation time.

In vitro cellular experiments show that the nanocomplexes irradiated by 660 nm laser have a strong ability to produce singlet oxygen, which effectively induces PDT. PDT with strong immunogenicity leads to tumor necrosis and apoptosis and induces immunogenic cell death, which causes tumor cells to release danger-associated molecular patterns. In combination with iPD-L1, the combination therapy stimulates dendritic cell maturation, promotes T-cell activation and intratumoral infiltration, and reshapes the tumor immune microenvironment to achieve tumor growth inhibition and anti-distant tumor progression.

MOFs-based nano-systems as a platform for combination therapy offer a potentially effective strategy for the treatment of TNBC with high metastatic rates [1].

Liang et al.'s study presents an innovative and potentially effective strategy for TNBC treatment. However, the findings should be interpreted with caution due to the current stage of the research. Additional studies, particularly in vivo experiments and clinical trials, are essential to validate the safety, efficacy, and clinical relevance of this MOF-based combination therapy. The study lays a foundation for further exploration in the field of cancer therapeutics, emphasizing the importance of interdisciplinary approaches in cancer research.

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Liang X, Mu M, Chen B, Fan R, Chen H, Zou B, Han B, Guo G. Metal-organic framework-based photodynamic combined immunotherapy against the distant development of triple-negative breast cancer. Biomater Res. 2023 Nov 24;27(1):120. doi: 10.1186/s40824-023-00447-x. PMID: 37996880.