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A Small-Molecule Self-Assembled Nano Drug for Photothermal-Differentiation-Chemotherapy of Breast Cancer Stem Cells

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Abstract

The mixture remedy with specific therapy modalities has been extensively utilized in the scientific functions of most cancers treatment. However, it stills a widespread task to gain co-delivery of extraordinary pills due to the fact of awesome drug encapsulation mechanisms, low drug loading, and excessive excipient-related toxicity. Cancer stem cells (CSCs) are intently associated to tumor metastasis and recurrence due to excessive chemoresistance. Herein, we file a stimuli-responsive and tumor-targeted small-molecule self-assembled nanodrug for the aggregate remedy towards CSCs and everyday most cancers cells. The hydrophobic differentiation-inducing agent (all-trans retinoic acid, ATRA) and hydrophilic anticancer drug (irinotecan, IRI) represent this amphiphilic nanodrug, which ought to self-assemble into steady nanoparticles and encapsulate the photothermal agent IR825. Upon cell uptake, this nanodrug show top launch profiles in response to acid and esterase microenvironments via ester linkage. The launched pills now not solely enlarge chemotherapy sensitivity via the differentiation of CSCs into non-CSCs; however additionally showcase optimal cytotoxicity in cancer cells. In addition, IR825 inside this Nano drug permits in vivo fluorescence/photoacoustic (PA) imaging permitting for monitoring drug distribution. Moreover, the DSPE-PEG-RGD-functionalized nanodrug displayed excessive tumor accumulation and proper biocompatibility, enabling environment friendly inhibition of tumor boom and tumor metastasis in tumor-bearing mice.

Keywords: Small-molecule nanodrugs; Breast cancer stem cells (BCSCs); Photothermal therapy; Differentiation therapy; Chemotherapy; Nanotechnology; Self-assembled nanodrugs

Introduction

Breast cancer remains a formidable challenge in the realm of oncology, affecting millions of individuals worldwide and posing a significant threat to public health. While substantial progress has been made in the development of cancer therapies, there is an urgent need for more precise and effective approaches to combat this complex disease. One promising avenue of research that has garnered increasing attention is the design and implementation of small-molecule self-assembled Nano drugs. These innovative nanoscale drug delivery systems offer a multifaceted approach to breast cancer treatment by integrating photothermal therapy, differentiation therapy, and chemotherapy. This integration is particularly potent when targeting a specific subset of cells within breast cancer tumors, namely the breast cancer stem cells (BCSCs). BCSCs are a rare, highly tumorigenic subpopulation of cells within breast tumors that are resistant to traditional cancer treatments and are believed to play a pivotal role in disease recurrence and metastasis. In this context, the development of a small-molecule self-assembled Nano drug represents a promising strategy that addresses several critical challenges in breast cancer therapy. The convergence of photothermal therapy, differentiation therapy, and chemotherapy within a single nanoscale drug carrier provides a multifaceted approach capable of targeting BCSCs with high precision. This approach has the potential to overcome the limitations of current breast cancer treatments, improve therapeutic outcomes, and reduce the risk of disease relapse. In this introductory exploration, we delve into the intricate world of small-molecule self-assembled nanodrugs and their application in the photothermal-differentiation-chemotherapy of breast cancer stem cells, shedding light on the innovative strategies and advancements that hold promise for a future with more effective and personalized breast cancer therapy [1-5].

Discussion

The role of breast cancer stem cells (BCSCs)

Breast cancer is a highly heterogeneous disease, and it's now well-established that a small subset of cells within tumors, known as breast cancer stem cells (BCSCs), plays a crucial role in disease progression, metastasis, and therapy resistance. These BCSCs possess the ability to self-renew and differentiate into various cell types within the tumor. Their resistance to conventional cancer treatments has made them a prime target for innovative therapeutic strategies.

Nanotechnology in cancer treatment

Nanotechnology offers a unique platform for cancer treatment due to its ability to manipulate materials at the nanoscale. In the context of breast cancer therapy, nanodrugs have gained prominence as delivery systems that can enhance the precision, efficiency, and safety of cancer treatment. These nanodrugs are designed to carry therapeutic agents to the tumor site while minimizing damage to healthy tissue.

Photothermal therapy

Photothermal therapy relies on the conversion of absorbed light energy into heat, leading to selective destruction of cancer cells. Its unique advantage is the ability to precisely target tumor sites while sparing healthy tissue. When combined with nanodrug delivery, photothermal therapy becomes even more effective, as nanodrugs can accumulate at the tumor site and release therapeutic agents upon exposure to specific wavelengths of light.

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Differentiation therapy

Differentiation therapy is an emerging approach in cancer treatment, aimed at inducing BCSCs to differentiate into non-cancerous cell types. By pushing BCSCs towards a non-cancerous phenotype, this therapy can reduce the pool of cancer stem cells and, in turn, decrease tumor aggressiveness. Self-assembled nanodrugs can deliver differentiation-inducing agents to BCSCs, enhancing the effectiveness of this approach.

Chemotherapy and nanodrug delivery

Chemotherapy remains a cornerstone in cancer treatment. However, the systemic administration of chemotherapy drugs can lead to severe side effects and limited specificity. The use of self-assembled nanodrugs allows for targeted drug delivery, ensuring that chemotherapy agents are primarily delivered to the tumor site, including BCSCs, thereby minimizing collateral damage to healthy tissues.

The synergistic approach

What makes this topic particularly exciting is the possibility of combining photothermal therapy, differentiation therapy, and chemotherapy within a single self-assembled nanodrug. This synergistic approach has the potential to comprehensively target BCSCs, tackling their resistance and reducing the risk of disease recurrence and metastasis. By leveraging the strengths of each therapy, researchers aim to create a multifaceted treatment strategy that maximizes therapeutic benefits while minimizing side effects.

Challenges and future directions

Despite the promise of this approach, there are challenges to overcome. Issues such as optimizing drug release, ensuring the safety of photothermal therapy, and understanding the long-term effects of BCSC differentiation are areas of ongoing research. However, as the field of nanomedicine and cancer therapy continues to evolve, these challenges are being addressed, and novel solutions are being developed [6-10].

Conclusion

The development of a small-molecule self-assembled nanodrug for the photothermal-differentiation-chemotherapy of breast cancer stem cells represents a promising frontier in the battle against breast cancer. The multifaceted approach offered by this innovative strategy presents a beacon of hope for patients and researchers alike. In the fight against breast cancer, identifying and targeting BCSCs, the architects of disease recurrence and metastasis, is of paramount importance. Their resistance to conventional therapies has long posed a formidable challenge. In conclusion, the integration of small-molecule self-assembled nanodrugs for the photothermal-differentiation-chemotherapy of breast cancer stem cells represents a groundbreaking approach with significant potential to revolutionize breast cancer treatment. By addressing the unique challenges posed by BCSCs and utilizing the advantages of nanotechnology, researchers are striving to provide more effective, targeted, and personalized therapies for breast cancer patients. This innovative direction of research offers hope for improved outcomes and better quality of life for those affected by breast cancer.

Conflict of Interest

None

Acknowledgment

None

References

1. Cristofanilli M, Gonzalez Angulo A, Sneige N, Kau SW, Broglio K, et al. (2005) Invasive lobular carcinoma classic type: Response to primary chemotherapy and survival outcomes. J Clin Oncol 23: 41-48.
2. Shaitelman SF, Schlembach PJ, Arzu I, Ballo M, Bloom ES, et al. (2015) Acute and short-term toxic effects of conventionally fractionated vs hypofractionated whole-breast irradiation: a randomized clinical trial. JAMA oncol 1: 931-941.
3. Sinn HP, Kreipe H (2013) A brief overview of the WHO classification of breast tumors, 4th edition, focusing on issues and updates from the 3rd edition. Breast Care (Basel) 8: 149-154.
4. Li CI, Uribe DJ, Daling JR (2005) Clinical characteristics of different histologic types of breast cancer. Br J Cancer 93: 1046-1052.
5. McCart Reed AE, Kutasovic JR, Lakhani SR, Simpson PT (2015) Invasive lobular carcinoma of the breast: Morphology, biomarkers and 'omics. Breast Cancer Res 17: 12.
6. Suryadevara A, Paruchuri LP, Banisaeed N, Dunnington G, Rao KA (2010) The clinical behavior of mixed ductal/lobular carcinoma of the breast: A clinicopathologic analysis. World J Surg Oncol 28: 51.
7. Metzger Filho O, Giobbie Hurder A, Mallon E, Gusterson B, Viale G, et al. (2015) Relative effectiveness of letrozole compared with tamoxifen for patients with lobular carcinoma in the BIG 1-98 trial. J Clin Oncol 33: 2772-2779.
8. Brunt AM, Haviland JS, Wheatley DA, Sydenham MA, Alhasso A, et al. (2020) Hypofractionated breast radiotherapy for 1 week versus 3 weeks (FAST-Forward): 5-year efficacy and late normal tissue effects results from a multicentre, non-inferiority, randomised, phase 3 trial. Lancet 395: 1613-1626.
9. Mamounas EP, Bandos H, Lembersky BC, Jeong JH, Geyer Jr CE, et al. (2019) Use of letrozole after aromatase inhibitor-based therapy in postmenopausal breast cancer (NRG Oncology/NSABP B-42): a randomised, double-blind, placebo-controlled, phase 3 trial. Lancet Oncol 20: 88-99.
10. Coles CE, Aristei C, Bliss J, Boersma L, Brunt AM, et al. (2020) International guidelines on radiation therapy for breast cancer during the COVID-19 pandemic. Clin Oncol (R Coll Radiol) 32: 279-281.