



# Exploring Therapeutic Strategies for Tumour Stem Cells in Digestive Tract Tumours

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**Abstract:** To explore the potential and challenges of tumour stem cells in the treatment of digestive tract tumours, the article analyses the key role of tumour stem cells in tumourigenesis and treatment resistance using a systematic review as an approach. Tumour stem cells are capable of self-renewal and multidirectional differentiation, which have a significant impact on long-term tumour survival and recurrence. Therapeutic strategies for targeting tumour stem cells include labelling and isolation techniques as well as the development of targeted drugs aimed at improving therapeutic efficacy and prolonging patient survival. However, therapeutic resistance caused by tumour stem cells remains one of the challenges and requires further in-depth studies and effective therapeutic strategies, providing theoretical support for future clinical studies and the development of individualized treatment protocols.

**Keywords:** tumour stem cells; gastrointestinal tract tumours; therapeutic strategies

## 1. Introduction

Digestive tract tumours are one of the common malignant tumours in clinical practice and their treatment strategies are constantly evolving. In recent years, tumour stem cells have attracted widespread attention as a key factor in tumourigenesis and development. Tumour stem cells have the ability of self-renewal and multidirectional differentiation, which have an important impact on tumour drug resistance and recurrence. Therefore, in-depth study of tumour stem cells and their therapeutic strategies in digestive tract tumours is of great significance to improve the therapeutic efficacy and prolong the survival of patients.

## 2. Characteristics and Functions of Tumour Stem Cells

### 2.1 Definition and characteristics of tumour stem cells

Tumour stem cells are a class of cell populations with self-renewal ability and multidirectional differentiation potential, which play a crucial role in tumour genesis, development and their therapeutic response. First of all, tumour stem cells have significantly different characteristics from ordinary tumour cells. While ordinary tumour cells usually show limited proliferation and differentiation potential, tumour stem cells have the ability to maintain their own numbers for a long period of time, similar to normal stem cells, and at the same time are capable of generating different types of tumour cells. Secondly, the definition of tumour stem cells may vary slightly in different types of tumours, but their basic characteristics include: firstly, they are capable of self-renewal, i.e. they are able to generate a population of stem cells that are identical to their own; secondly, they have the potential for multidirectional differentiation, which allows them to differentiate into different types of tumour cells, thus maintaining the heterogeneity of tumours. These features enable tumour stem cells to evade clearance by conventional treatment during the course of therapy, leading to tumour recurrence and metastasis. Further exploring the properties of tumour stem cells, their ability to self-renew is usually determined by tracking marker stem cells and their progeny over time [1]. This ability allows tumour stem cells to rebuild tumour tissue after treatment, even if the initial tumour cells are effectively removed. At the same time, the multidirectional differentiation potential of tumour stem cells allows them to form different types of tumour cells, including subpopulations of cells that are better adapted to different microenvironmental conditions.

### 2.2 The role of tumour stem cells in GI tumours

The role of tumour stem cells in digestive tract tumours is an area of research that has received much attention, and they have a significant impact on tumourigenesis, progression, and therapeutic response. GI tumours include oesophageal, gastric and colon cancers, and the therapeutic effects of these tumours are often influenced by the presence and activity of tumour stem cells. First, tumour stem cells play a key role in GI tumourigenesis. They possess self-renewal and unrestricted

proliferation ability, which can sustain tumour growth for a long time. Tumour stem cells in GI tumours may be derived from intestinal epithelial stem cells or other tissue stem cells, which have acquired the properties of tumour stem cells through mutation or environmental stimulation, thus driving tumour formation. Secondly, tumour stem cells contribute significantly to treatment resistance in GI tumours. Due to their high resistance to radiotherapy drugs, tumour stem cells are often the main cause of tumour recurrence and metastasis after treatment. This resistance is closely related to the cell cycle quiescence, enhanced DNA repair capacity, and epigenetic regulation of tumour stem cells, making it difficult to completely eradicate them with conventional treatments. Further exploration of the role of tumour stem cells in GI tumours also requires consideration of their ability to regulate the tumour microenvironment. Tumour stem cells maintain tumour growth and evade host immune surveillance by secreting specific cytokines and modulating signalling pathways that influence the behaviour of surrounding tumour cells and the response of immune cells.

### **3. Therapeutic Strategies for Tumour Stem Cells in GI Tumour Therapy**

#### **3.1 Therapeutic Approaches Targeting Tumour Stem Cells**

##### **3.1.1 Tumour stem cell labelling and isolation techniques**

The application of tumour stem cell labelling and isolation technology in GI tumour therapy is a key research and clinical strategy. This technique aims to identify and isolate subpopulations of tumour cells with stem cell properties in order to further study their biological behaviour and explore targeted therapeutic approaches. Firstly, labelling techniques for tumour stem cells allow researchers to identify these cells by specific markers or characteristic molecules. Commonly used markers include specific antigens on the cell surface, specific fluorescent probes, or marker genes introduced through genetic engineering techniques. These markers are able to distinguish tumour stem cells from non-stem cell tumour cells, thus helping to accurately isolate and purify tumour stem cell subpopulations. Secondly, the development of isolation techniques has enabled researchers to accurately isolate tumour stem cells in tumour samples, which is essential for in-depth study of their role in tumorigenesis and progression. For example, by flow cytometry, magnetic bead separation technology or microfluidics, tumour stem cells can be specifically captured according to different markers to analyse their gene expression, epigenetic status and regulatory pathways [2]. Further exploring the significance of tumour stem cell labelling and isolation techniques, these techniques not only help to identify stem cell subpopulations in tumours, but also provide a basis for the development of personalised therapeutic strategies. By gaining a deeper understanding of the properties and behaviours of tumour stem cells, researchers can design targeted therapeutic approaches for their specific biological characteristics, such as targeting specific signalling pathways or using targeted drugs to act directly on tumour stem cells.

##### **3.1.2 Drug development targeting tumour stem cells**

Drug development targeting tumour stem cells is one of the cutting-edge research areas in the field of GI tumour therapy, with the goal of effectively treating and controlling tumour progression by acting specifically on tumour stem cells. This strategy for drug development involves several key steps and techniques to ensure that the drug accurately identifies and destroys the stem cell subpopulation in the tumour. First, successful drug development requires an accurate understanding of the critical role of tumour stem cells in tumour growth and recurrence. Studies have shown that tumour stem cells have the capacity for self-renewal and pluripotency, and are resistant to the effects of conventional chemotherapeutic drugs, making targeted drugs that are specific to them particularly important. Through molecular biology and genetic studies, scientists can reveal the differences between tumour stem cells and ordinary tumour cells, thus providing a theoretical basis for drug design. Secondly, the key to the drug design stage lies in the selection or development of targeting molecules with high specificity and affinity. For example, drugs can be designed using specific antibodies, small molecule inhibitors or gene-targeting technologies, which are capable of targeting and interfering with the biological functions of tumour stem cells, such as self-renewal ability and tumourigenic signalling pathways. During the experimental validation phase of drug development, commonly used techniques include in vitro cellular assays and animal model assays. These experiments are able to assess the biological activity, toxicity and in vivo pharmacodynamic properties of the drug and provide data support for further preclinical studies and clinical trials. Finally, the clinical trial stage is an important step in moving drugs targeting tumour stem cells from the laboratory to clinical application. Clinical trials not only verify the safety and efficacy of the drug, but also assess its impact on patient clinical outcomes, such as improved survival, tumour shrinkage or stabilisation.

#### **3.2 Relationship between tumour stem cells and treatment resistance**

##### **3.2.1 Mechanisms of tumour stem cells and resistance to chemotherapy and radiotherapy**

Tumour stem cells (CSCs) are a special subpopulation of cells with self-renewal ability and pluripotency, which enables

them to escape the attack of conventional chemotherapy and radiotherapy during treatment, leading to treatment failure and tumour recurrence. Firstly, tumour stem cells exhibit a higher ability to express multidrug resistance proteins (MDR). The MDR protein family includes ABC transporters, which are able to excrete drugs from the cell by actively transporting them, thereby reducing the effective concentration of the drug in the cell and decreasing the therapeutic efficacy of the drug. This increased expression of MDR allows tumour stem cells to effectively resist the effects of multiple chemotherapeutic drugs, thus maintaining their ability to survive and proliferate. Secondly, tumour stem cells are more active for DNA damage repair mechanisms. Conventional chemotherapy and radiotherapy kill tumour cells by inducing DNA damage, however, tumour stem cells tend to be able to repair these damages more efficiently and protect themselves from the effects of treatment. This efficient DNA repair mechanism gives tumour stem cells a survival advantage over other tumour cells, and they tend to survive and re-expand more readily after treatment. In addition, tumour stem cells exhibit lower proliferation rates and metabolic activity. This makes them more likely to become dormant or metabolically slowed down during treatment than rapidly proliferating tumour cells, thus reducing the killing effect of chemotherapy and radiotherapy. This "dormant state" allows tumour stem cells to regain activity after treatment, increasing the risk of tumour recurrence [3].

### 3.2.2 Strategies to overcome treatment failure due to tumour stem cells

The presence of tumour stem cells and drug resistance is an important challenge in current cancer treatment, but these problems can be effectively overcome through a combination of strategies and technologies that can improve the effectiveness of treatment and patient survival. Firstly, the development of novel drugs targeting tumour stem cells is an important pathway. These drugs achieve therapeutic goals by specifically identifying and inhibiting the growth and self-renewal capabilities of tumour stem cells. For example, the development of antibody drugs targeting surface markers of tumour stem cells or the design of small molecule inhibitors targeting their specific signalling pathways can effectively reduce the resistance of tumour stem cells and improve the sensitivity of chemotherapy and radiotherapy. Second, combining conventional treatment with immunotherapy is also a promising strategy. Immunotherapy can attack tumour cells, including tumour stem cells, by activating the patient's own immune system. For example, the use of CAR-T cell therapy or immune checkpoint inhibitors can improve the immune system's ability to recognise and remove tumour stem cells to a certain extent, thereby reducing the risk of tumour recurrence. In addition, combination therapy strategies have shown some potential. Through the simultaneous or sequential application of drugs with different mechanisms and targets, such as the combination of chemotherapeutic agents and targeted therapeutic agents, tumour cells, including tumour stem cells, can be attacked at multiple levels, thus improving the overall effect of treatment and the survival rate of patients.

## 4. Conclusion

In summary, tumour stem cells in digestive tract tumours have important biological properties and clinical significance. They play a key role in long-term tumour survival and recurrence through self-renewal and multidirectional differentiation ability, and are also one of the main causes of resistance to chemotherapy and radiotherapy. To overcome these challenges, current research focuses on the development of novel therapeutic strategies targeting tumour stem cells, including labelling and isolation techniques as well as the development of targeted drugs. These strategies not only help to improve therapeutic efficacy and prolong patient survival, but also provide theoretical support for the development of personalised treatment plans. However, further in-depth studies on the biological mechanisms of tumour stem cells and their precise role in tumour development are still needed to achieve effective treatment.

## References

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