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Review Article

Preoperative Cancer Nano medicine: Neoadjuvant Chemotherapy, Radiation, Immunotherapy, And Phototherapy Made Possible by Nanotechnology

Zhang Shang*

Department of General Surgery, China

ABSTRACT

Malignant solid tumours are still mostly treated with surgical resection. However, in the past 10 years, there has been an increase in interest in the use of neo-adjuvant therapies, such as chemotherapy, radiation, phototherapy, and immunotherapy, either alone or in combination, as a preoperative intervention regimen [1].

The survival rates of long-term neoadjuvant treatment and adjuvant therapy have not been significantly different in early randomised, controlled studies in several tumour situations. However, due to the clear down staging of primary tumours to define the surgical margin, the ability to tailor systemic therapy response as a clinical tool to optimise subsequent therapeutic regimens, and the reduction in the need for surgery with its potential for increased morbidity, neoadjuvant treatments are being used more frequently in clinical practise. Neo-adjuvant treatment for preoperative therapies now faces obstacles that can be addressed with a new strategy thanks to the recent advancements in nanotechnology-based Nano medicine and associated medical technologies [2]. This study highlights the potential use of nanomedicine as neoadjuvant therapy in preclinical and clinical settings for tumour management in addition to summarising how crucial a role Nanomedicine plays in a variety of neoadjuvant therapeutic methods [3].

INTRODUCTION

Conventional surgical excision continues to be a cornerstone in the management of the majority of solid tumours, despite advancements in theranostic technologies for oncology. New surgical techniques, such as precise surgical resection guided by multimodal imaging, minimally invasive laparoscopic and robotic surgery, enhanced preoperative planning, and attentive postoperative nursing care, are, nevertheless, continuously enhancing the effectiveness of surgical treatment. Preoperative treatment, also known as neoadjuvant therapy, is a therapeutic course of treatment that is administered before to surgery and is receiving more and more attention. Preoperative treatment has a number of benefits, such as down staging the primary tumour to lessen the burden of local and regional disease, delineating the tumour margins for ease of resection and to reduce over-excision of adjacent healthy tissue, and customising systemic therapy response as a clinical tool to optimise Adjuvant therapy is follow-up treatment [4]. Despite utilising the same therapeutic agents as standard adjuvant therapy, early randomised studies in breast cancer patients revealed that the addition of neoadjuvant chemotherapy (NACT) to the treatment plan did not result in appreciable variations in survival or long-term prognosis. Similar to this, individuals with rectal cancer who underwent routine neoadjuvant chemo-radiotherapy (nCRT) continue to have basically unaltered long-term survival rates [5].

A more recent larger randomised clinical trial discovered that the addition of bevacizumab, a monoclonal antibody that targets the vascular endothelial growth factor, to the neoadjuvant therapy regimen could significantly increase the complete pathological response rate without any obvious toxic side effects. This was in contrast to either capecitabine or gemcitabine alone [6]. These promising findings imply that tailored therapy will perform better in neoadjuvant therapy. Similar neoadjuvant therapeutic effects would be produced by targeted administration of neoadjuvant therapeutic medicines to malignancies. As a result, the potential of nanotechnology-based nanomedicine to target cargos to certain areas, including tumours, was used for neoadjuvant therapy [7]. A few benefits of nanomedicine are regulated cargo release, easy multi-modal theranostic integration, and safe and effective targeted

***Correspondence to**: Zhang Shang, Department of General Surgery, china, E-mail: shangzhang@rediff.com

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medication delivery. Additionally, substantial study has been done on the use of nanoparticles in medicine, with several applications in the detection and treatment of cancer.More study is necessary, nevertheless, before nanomedicine may be used as a neoadjuvant [8].

Recently, several clinical studies have incorporated commonplace nanomedicine methods into their neoadjuvant regimen, including liposome-encapsulated doxorubicin and nanoparticle albumin-bound paclitaxel. These trials have confirmed the safety and effectiveness of the preoperative, neoadjuvant therapy formulations employed, and they have also increased the number of patients who achieve a pathological complete response [9]. The success of these experiments has raised interest in investigations looking at how nanomedicine might be used as a neoadjuvant therapy. The fast development of nanomedicine based on nanotechnology and its significance in medical practise may help to progress the clinical use of neoadjuvant therapy [10].

CONCLUSION

The main and best treatment option for the majority of solid tumors is still surgical excision. Therefore, for successful surgical results, preoperative tumour resection planning (such as determining the malignant tumour margins), imaging-guided surgery during surgery, and after full resection verification and care are essential. In order to enhance cancer theranostics and surgical resection, multifunctional Nano platforms that integrate optical and medical imaging technologies are being developed and put to use [11]. Conventional preoperative and intraoperative single imaging methods have a number of drawbacks, including low specificity, tiny surgical windows for small molecule imaging, quick clearance from the body, and limited penetration for optical imaging [12].

By combining the benefits of many imaging modalities and the supremacy of nanotechnology into a single application, nanoplatform-based multimodal imaging, in contrast, might achieve unmatched advantages in improved sensitivity, specificity, and spatial resolution. For instance, the use of MRI, photoacoustic, and Raman nanoparticles in triple-modality imaging and excision of brain tumours clearly demonstrates superiority [13]. By fusing MRI and NIR-II imaging into the cuttlefish melanin nanoparticle, the natural cuttlefish melanin nanoprobe demonstrates distinct benefits in preoperative and intraoperative mapping of lymphatic metastases in sentinel lymph nodes (SLN). Although numerous imaging modalities might be formed into the nanoplatform to create multimodal imaging nanoprobes, it is difficult to design new multimodal imaging nanoprobes without first identifying adequate and usable imaging equipment [14]. A thorough treatment management programme that includes preoperative diagnosis, evaluation, neoadjuvant treatment, intraoperative real-time multimodal imaging and evaluation, multiple drug combination management, postoperative adjuvant treatment, recurrence prevention, wound healing care, and anti-infection management also includes tumour surgical resection. However, few few therapeutic paradigms now in use are able to concurrently take into account and address this comprehensive cancer care strategy before and/or after surgery. Therefore, it may be practical and universal to design some trustworthy treatment modalities that can handle and cover the entire course of tumour management. Nano medicine based on nanotechnology could make this possible [15].

The Nano medicine-based multifunctional injectable hydrogel successfully suppressed post-operative tumour recurrence and avoided postoperative adhesion. It also demonstrated preoperative tumour burden remission by mild PTT-enhanced chemotherapy. It is important to note that nanomedicines that are fitted to the entire phase of tumour therapy rather than simply preoperative administration would be an exciting consequence.

Nano medicine-mediated tumour immunotherapy has advanced significantly, but its use in neoadjuvant immunotherapy, particularly neoadjuvant combination immunotherapy, is still in its early stages. In reality, the term "hot" tumour refers to the presence of numerous proinflammatory anti-tumor immune cells in the TME during the early stages of the tumour, such as M1 macrophages, DCs, and CD8+ T cells.

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