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Review Article

Multi-Disciplinary and Multi-Modality in the Treatment of Brain Tumors

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Abstract

Brain tumors have become a major public health problem for its high morbidity and mortality and heavy economic burden. To tackle the knotty problem is urgently required. Over the last several decades have witnessed a great progress in various aspects of brain tumors from diagnosis to therapy. These advances cover molecular biology researches, neuro imaging and neurosurgical techniques, radiation therapies, and chemobiologic therapy agents. Multi-disciplinary and multi-modality protocol management strategy has been applied to integrate these achievements and provide new insights and potential benefits in the management of brain tumors. The goals of this review article are to give the reader an overview of current therapeutic strategies and researches involved in the treatment of brain tumors.

Keywords: Brain tumors; Neurosurgery; Multi-disciplinary; Multi-modality; Treatment

Abbreviations

fMRI: Functional Magnetic Resonance Imaging; DTI: Diffusion Tensor Imaging; DWI: Diffusion-Weighted Imaging; MRS: Magnetic Resonance Spectroscopy; WBRT: Whole-Brain Radiation Therapy: SRS: Stereotactic Radiosurgery: GKS: Gamma Knife Radiosurgery

Introduction

Brain tumors, representing an important area of cancer, pose a major threat to public health worldwide. In 2016, an estimated 23,770 people in the United States were newly diagnosed with brain tumors, and these tumors will be responsible for approximately 16,050 deaths [1]. In China, an estimated 101.6 per 100,000 new brain tumors cases and 61.0 per 100,000 cancer deaths would occur in 2015 [2]. The incidence rates are estimated to be increased in most countries since 1990 [3,4]. Considering the potential heavy burden of this disease, prevention, screening, diagnosis, and treatment are urgently required. Over the last several decades have witnessed a great progress in molecular biology researches, neuroimaging and surgical techniques, radiation therapies, and newer chemobiologic therapy agents. The introduction of multi-disciplinary and multi-modality protocols management strategy is applied to integrate these achievements, and the lower rate of morbidity and mortality and higher long-term survival rate have been obtained. A review of the literature was performed using Medline, PubMed and Cochrane databases, which focused on therapeutic strategies and researches involved in the treatment of brain tumors.

Multi-Disciplinary Treatment

On the one hand, it is difficult to treat disease such as glioblastomas by using a single treatment modality; on the other hand, increasing specialization and complexity of knowledge has led to the introduction of multi-disciplinary for the management of patients with cancers [5]. Therefore, multi-disciplinary management which comprised neurosurgery, radiology, and oncology and rehabilitation medicine is necessary for the development of more effective and safe therapy [6]. Furthermore, the rationale for introducing multidisciplinary teams is that as the management of disease becomes more and more complex, it is important to involve all key professional groups in making clinical decisions for individual patients [7]. Team key members generally are composed of neurosurgeons, neurologists, oncologists, radiologists, rehabilitation physicians and specialist nurses. Consideration should be given to defining patients meet the criteria and specific management pathways for brain tumors' patients in practice. Future research into the quality of Multi-disciplinary management should be encouraged.

Multi-Modality Treatment

Multi-modality which including neurosurgery, radiation therapy, and chemobiologic therapy has been used in the management of brain tumors. Multi-modality strategy is now well established in the management of brain tumors to improve patient and clinician satisfaction with reducing mortality and improving the patients' quality of life [8]. Different treatment strategies have their advantages to balance its shortfall based on the individual's circumstances. However, combination of one or more patterns in the management tumors maybe a promising strategy.

Neuroimaging and Surgical Techniques

There exist a close relationship between Neuroimaging and surgery. The combination of advanced neuroimaging and neurosurgery in the diagnosis and treatment of brain tumors has been demonstrated an excellent advantage. Surgery remains an important part of the treatment of brain tumors [9]. The utilization of high-resolution imaging techniques such as functional Magnetic Resonance Imaging (fMRI), Diffusion Tensor Imaging (DTI), Diffusion-Weighted Imaging (DWI), Magnetic Resonance Spectroscopy (MRS) and so on established precise diagnosis [10]. Intraoperative navigation, neurophysiological monitoring and awake craniotomy which are increasingly used in neurosurgical planning

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and greatly improved the surgical outcome and decreased the risk of surgery-related complications [11]. Neurosurgeons also accept neurosurgical training includes acquisition of critical knowledge of neurological anatomy and function and surgical skill associate with patients' outcomes [12]. However, the widespread adoptions of these techniques in neurosurgical practice are limited by the lack of standardized methods. Therefore, deepen the understanding of each technique's strengths and weaknesses are still needed.

Radiation Therapy

Radiation therapy plays an important role in the management of most malignant and many benign primary brain tumors [13]. With the goal of achieving uncomplicated local tumor control, balancing between benefits and side effects is the art of radiation oncology. New radiation modalities such as intensity-modulated radiotherapy or alternative radiation sources such as heavy particle therapy (i.e., proton, carbon ion) is now applied in the treatment of brain tumors [14]. Here, we describe two representative modes, Whole-Brain Radiation Therapy (WBRT) and Stereotactic Radiosurgery (SRS).

Whole-Brain Radiation Therapy (WBRT)

WBRT as an upfront or conjunctive approach is commonly used in the treatment of brain metastases and malignant neoplasms such as high-grade glioma. The aims of WBRT are to improve intracranial disease control while decreasing the risk of neurotoxicity and other neurologic or neurocognitive complications. In more recent years, with the utilizing advanced radiotherapy techniques, the longer survival times with lower radiation associated complications are now observed [15]. The stereotactic radiosurgery such as Gamma Knife Radiosurgery (GKS) increasingly used in neurosurgical practice, however, WBRT still plays its role in the management brain tumors.

Stereotactic Radiosurgery (SRS)

In the 1950s, Lars Leksell, a Swedish neurosurgeon was first to develop SRS to treat benign brain tumors, arteriovenous malformations and other diseases [16]. Over time the procedure evolved, its focus expanded [17]. Stereotactic radiosurgery involves the delivery of a very precise, focal high dose of radiation to a target and low adverse effect. Since the mid-1990s, SRS has achieved a prominent role in the management of both brain and spinal benign and malignant tumors [18]. SRS like GKS has distinctive advantages in the treatment of deep brain lesions and eloquent areas. According to data obtained from Elekta AB, the manufacturer of GKS technology, more than 700,000 patients underwent brain SRS worldwide during the last 33 years [19]. Therefore, we have reasons to believe that the field of SRS will continue to grow in importance.

Chemobiologic Therapy

Gliomas represent the most frequent type of brain tumor, and high-grade gliomas are among the most rapidly growing and devastating neoplasms [20,21]. Despite it can be management by surgery and radiotherapy, these tumors still with a high relapse and mortality. Chemotherapy has been introduced in this field. The role of chemotherapy in brain tumors had been investigated in the past. The central nervous system is a unique sanctuary site for malignant disease andmany of the commonly used chemotherapy agents has limited activity in brain tumors because of the blood-brain barrier [22]. Only a few drugs applied in the management of brain tumors. Temozolomide, for example, is now the most common and definitely drug which developed in the 1980s [23,24]. It has demonstrated antitumor activity as a single agent in the treatment of recurrent and new diagnosis glioma [25,26].

Other chemotherapy agents include methotrexate, cytarabine, and procarbazine and so on and its role in the treatment of brain tumors remains controversial.

Due to these limits and challenges exist in the treatment of brain tumors, researchers performed studies focused on the tumor cells microenvironment, genomic heterogeneity and the variable integrity of the blood–brain barrier [27-29]. Some preclinical tests have demonstrated high rates of efficacy for novel agents which bright new insight into the treatment of brain tumors [30]. These advances in brain tumor molecular biology maybe translate into the clinic for the next stage [31].

Conclusion

Brain tumors represent an important area of clinical practice. More and more clinicians and researchers are engaged in the fields of basic and clinical research of brain tumors. These researches' achievements increased our knowledge and understanding of the brain tumors and provided potential therapeutic strategy in the population with safer and more effective. Multi-disciplinary and multi-modality protocols management strategy has been applied to integrate the achievements and provide new insights and potential benefits in the management of brain tumors. Despite the current achievements, to achieve state-of-the-art therapy and the goal of the cure of cancer, there still have a long way to go. Efforts and cooperation from worldwide are needed.

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