

Tumor Metabolism with Different Immune Responses by Dynamic Glucose Enhanced (DGE) MRI

報告日期:2022/9/23

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神經膠細胞瘤(Glioma)是眾多腦瘤中難以處理的腫瘤，其中又以膠質母細胞瘤(Glioblastoma)為預後最差，統計資料顯示，不論處治方式病人的存活中位數僅介於 12-15 個月；治療方式仍以外科移除，放射線配合傳統化學治療為主。因此提供正確的腫瘤組織訊息對臨床治療是非常關鍵的。而診斷方法大多使用電腦斷層掃描(Computed tomogram, CT)、胸部 X-Ray 及核磁共振成像(Magnetic resonance imaging, MRI)三種方式。而膠質母細胞瘤，大多使用核磁共振成像方式做檢測。由於核磁共振成像對於軟組織有明顯的對比度，可利於判別大腦中膠質母細胞瘤。

近年來發現，癌症和免疫細胞的代謝是息息相關的。癌症的代謝不僅促進腫瘤的發生及生長，也在癌症信號中扮演重要角色。腫瘤和免疫細胞之間的代謝競爭，導致免疫細胞營養不足，且腫瘤微環境中偏酸性，從而影響免疫細胞的功能。

在核磁共振成像中，不僅可以觀察膠質母細胞瘤的型態，也可利用活體磁共振頻譜(*in vivo* MR spectroscopy, MRS)及動態葡萄糖增強影像(Dynamic Glucose Enhanced MRI, DGE MRI) 觀察腫瘤中的化學成分。我的實驗將利用核磁共振成像中動態葡萄糖增強方法，在活體的小鼠中，觀察不同免疫條件下腫瘤的代謝。目前實驗觀察到兩個現象:一、沒有免疫細胞浸潤的腫瘤，與有免疫細胞浸潤的腫瘤相比，攝取葡萄糖的速度較快。二、腫瘤與對側的腦組織進行比較，發現腫瘤區域攝取的葡萄糖較多。未來的實驗方向會針對幾種代表性代謝物，例如乳糖(Lactate)、精氨酸(Arginine)等去做觀察，藉以找出代謝與腫瘤免疫反應的關聯。

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Date:2022/9/23

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Glioma is one of the brain tumor that is difficult to be treated, and glioblastoma is the worst one. The patient median survival is between 12-15 months. The most effective treatment methods are surgical removal and radiation combined with traditional chemotherapy. Therefore, how to provide accurate information of tumor tissues are crucial to the clinical treatments. Most of the diagnostic methods use computed tomography (CT), chest X-Ray and magnetic resonance imaging (MRI). Glioblastomas are mostly detected by magnetic resonance imaging since MRI shows good contrast in soft tissue. Therefore, it can be helpful to identify glioblastoma in the brain.

In recent years, it has been found that the metabolism of cancer and immune cells are closely related. Cancer metabolism not only promotes tumorigenesis and growth but also plays an important role in cancer signaling. Metabolic competition between tumor and immune cells results in insufficient nutrition of immune cells. In addition, the tumor microenvironment is acidic, which affects the function of immune cells.

In MRI, not only the morphology of glioblastoma but also the chemical composition of the tumor can be observed using *in vivo* MR spectroscopy (MRS) and Dynamic Glucose Enhanced (DGE) MRI. My study is using DGE MRI to investigate tumor metabolism under different immune conditions *in vivo*. Two phenomena have been observed so far; First, tumors without immune cell infiltration has a faster uptake of glucose than tumors with immune cell infiltration. Second, in the comparison of the tumor and the contralateral brain tissue, the tumor tissue region has more glucose uptake. In the future, we will investigate more representative metabolites, such as lactate and arginine, to find out the correlation between metabolism and immunology in the tumor tissues.