# 利用核磁共振成像動態葡萄糖增強法探討腫瘤細胞免疫反應之研究

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本研究旨在利用核磁共振成像技術中的動態葡萄糖增強法,探討腫瘤細胞在不同免疫反應狀況下的代謝特徵。神經膠細胞瘤（Glioma）為常見且頑固的腦瘤類型，其中膠質母細胞瘤（glioblastoma）具有最差的預後，患者存活期中位數僅為 12-15 個月。主要治療方法包括外科手術、放射治療及化學治療。目前主要的診斷電腦斷層掃描（Computed tomogram, CT）、胸部 X 光與核磁共振成像（Magnetic resonance imaging, MRI）。核磁共振成像尤其適用於膠質母細胞瘤診斷，因其在軟組織中具有較高的對比度。近年研究指出，癌症細胞與免疫細胞的代謝過程密切相關，癌症細胞的代謝既促進腫瘤生成和生長，又在癌症信號傳導中發揮重要作用。腫瘤與免疫細胞之間的代謝競爭導致免疫細胞營養不足，並使腫瘤微環境呈酸性，進一步影響免疫細胞功能。

本研究以動態葡萄糖增強法結合核磁共振成像技術(Dynamic Glucose Enhanced MRI, DGE MRI)，在活體小鼠模型中觀察不同免疫狀態下的腫瘤代謝。實驗結果顯示兩個主要現象。首先，在無免疫細胞浸潤的腫瘤中，葡萄糖攝取速度較有免疫細胞浸潤的腫瘤快。其次，與對側正常腦組織相比，腫瘤區域的葡萄糖攝取量明顯較高。這些發現表明，動態葡萄糖增強核磁共振成像可以作為探索腫瘤細胞與免疫細胞之間相互作用的有效手段，有望提高腦瘤診和治療的精確度。

# Investigating Tumor Immune Responses through Dynamic Glucose-Enhanced Magnetic Resonance Imaging

The aim of this study is to investigate the metabolic characteristics of tumor cells under different immune response conditions using Dynamic Glucose Enhanced (DGE) Magnetic Resonance Imaging (MRI) technique. Glioma is a common and stubborn type of brain tumor, among which glioblastoma has the worst prognosis, with a median survival period of only 12-15 months. The main treatment methods include surgery, radiation therapy, and chemotherapy. The primary diagnostic techniques are Computed Tomography (CT), chest X-rays, and Magnetic Resonance Imaging (MRI). MRI is particularly suitable for diagnosing glioblastoma due to its high contrast in soft tissues.

Recent studies have shown that the metabolism of cancer cells and immune cells are closely related. The metabolism of cancer cells not only promotes tumor formation and growth but also plays a crucial role in cancer signaling. The metabolic competition between tumors and immune cells leads to malnutrition of immune cells, acidification of the tumor microenvironment, and further impairment of immune cell function.

In this study, DGE MRI was combined with in vivo mouse models to observe the tumor metabolism under different immune conditions. The experimental results reveal two main phenomena. Firstly, in tumors without immune cell infiltration, the glucose uptake rate is faster than in tumors with immune cell infiltration. Secondly, compared with the contralateral normal brain tissue, the glucose uptake in the tumor area is significantly higher. These findings suggest that Dynamic Glucose Enhanced MRI can serve as an effective means to explore the interactions between tumor cells and immune cells, potentially improving the accuracy of brain tumor diagnosis and treatment.