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Insights on Identification of Brain Cancer by using Radio Genomics

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Introduction

Brain tumour characterization (BTC) is the process of determining the underlying cause and characteristics of brain tumours using various approaches such as tumour segmentation, classification, detection, and risk analysis. The identification of the molecular signature of various useful genomes whose alteration causes the brain tumour is a significant part of the brain tumour characterization. The radiomics approach extracts quantitative radiomics features from radiological images for disease characterization in an artificial intelligence (AI) environment. When considering a higher level of disease characteristics, such as genetic information and mutation status, the combined study of "radiomics and genomics" has been categorised as "radiogenomics." A brain tumour is a fatal disease, and the threat to human life is becoming more difficult as the global death toll rises. Brain and nervous system cancer is a common type that affects adult men, women, and children and is the tenth leading cause of death. The global burden of brain cancer continues to rise, imposing enormous physical, emotional, and monetary costs on individuals, families, communities, and healthcare systems. Many patients in countries with mediocre or poor healthcare support systems do not have access to timely standard diagnosis and treatment. Traditional brain tumour treatment includes chemotherapy, radiation therapy, biopsy, and surgery, depending on tumour size, type, location, and grade. Medical imaging techniques have been providing phenomenal results for the treatment as an addition to these traditional treatment methodologies. Magnetic resonance imaging (MRI), computed tomography (CT), cranial ultrasound imaging , and positron emission tomography (PET) are some of the medical image modalities that have been used to detect neurological disorders and brain tumours, with MRI being the most desirable option due to its soft tissue characteristics and radiation-free nature. The radiologist's manual inspection of the medical image to detect tumour features with disease characteristics, on the other hand, is laborious, and performance varies depending on the radiologist's experience.

Description

Artificial intelligence (AI) technologies such as machine learning (ML) and deep learning (DL) have demonstrated benefits in disease detection and classification [1]. Several ML methods have been developed for cancer diagnosis, including brain, liver, thyroid, tumour vascularity in breast cancer, ovarian, skin, diabetes, heart disease, and coronary artery disease [2]. These ML techniques have performed well; however, the feature extraction techniques are ad hoc, resulting in ML results that vary. Deep learning (DL) methods have recently emerged and have demonstrated several medical imaging applications, including brain cancer, carotid wall segmentation, COVID lesion detection, lung segmentation, and coronary/carotid plaque classification.

These DL techniques are unquestionably superior to ML, but they are extremely difficult to implement due to the high cost of training time [3]. New techniques like transfer learning (TL) and hybrid deep learning (HDL) have reduced training time for brain tumour classification, detection, and segmentation with a higher level of automation. These AI technologies have been able to extract tissue-based disease characteristics from medical images using various feature extraction methods, followed by segmentation and classification of disease characteristics. As a result, the combination of AI and radiography elevates brain cancer diagnosis to a new level [4]. The AI paradigm provides classification, detection, and segmentation for brain tumours, which has proven successful in terms of early detection, quality treatment, and survivability. However, for a higher diagnosis rate, the performance of these classification and segmentation methods must be improved further [5]. Because genetic mutation is the primary cause of brain cancer, detecting genomics information during brain tumour classification and segmentation can improve diagnosis. The exposure of healthy cells to external substances causes a change in the genes present in the cell, causing the cells to become cancerous. As a result, the primary cause of brain tumours that should be identified during diagnosis is genetic mutation.

Conclusion

The genomic assessment and status of genetic mutation on various genes and cell proteins, which are the molecular characteristics of the disease, can be detected from radiological medical imagery. In the proposed review for brain tumour characterization using radiomics and genomics features, we begin with brain tumour biology to understand the underlying process of brain tumours and the genomics mutation process in glia brain cells. The essential genetics that play a critical role in brain tumours are discussed, along with the mutation process and gene status. The classification and grading system of various brain tumours based on genetic mutations has also been tabulated to provide comprehensive information about the characterization of the brain tumour.

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