Current Research in MRI

Original Article

Ratio of Incidentally Detected Brain Tumors in Diffusion Magnetic Resonance Imaging Scans Performed in the Emergency Department on the Suspicion of Acute Stroke

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Cite this article as: Tobcu E, Karavaş E, Çelik Aydın Ö, Topçu B. Ratio of incidentally detected brain tumors in diffusion magnetic resonance imaging scans performed in the emergency department on the suspicion of acute stroke. *Current Research in MRI,* 2023;2(3):59-62.

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Received: August 04, 2023 **Accepted:** September 29, 2023 **Publication Date:** October 23, 2023

DOI:10.5152/CurrResMRI.2023.23077

Abstract

Objective: The aim of the study was to analyze the incidence of newly diagnosed brain tumors in diffusion magnetic resonance imaging (MRI) scans conducted in the emergency department of a tertiary care hospital.

Methods: In this retrospective study, we analyzed diffusion MRI examinations retrospectively with the preliminary diagnosis of acute stroke in the emergency department of a tertiary care hospital in Balıkesir in June 2023 and July 2023. We identified patients with brain tumors on diffusion MRI images and performed basic statistical analysis.

Results: Among 1544 patients, 121 patients were diagnosed with acute intracranial infarction (54 females and 67 males, median age: 71), and intracranial tumors were identified in 10 patients (5 females and 5 males, median age: 59.4). Further imaging methods were used to characterize the tumors. Intracranial tumors of 3 patients were diagnosed as metastasis, and the masses of 2 patients were pathologically diagnosed as glioblastoma multiforme. The masses of 3 patients were diagnosed with meningioma after radiological examinations. A cystic mass was observed at the level of the fourth ventricle in 1 patient, and a porencephalic cyst was diagnosed in the left frontal cortex in 1 patient.

Conclusion: Diffusion-weighted imaging (DWI) is the first-line radiological imaging method with computed tomography for the evaluation of stroke patients in emergency departments. Therefore, we think that it is crucial to report other radiological findings besides acute stroke on DWI images and to guide the physician about advanced radiological methods for characterization of lesions.

Keywords: Diffusion MRI, acute stroke, brain tumor

INTRODUCTION

Although there has been a decrease in the occurrence of ischemic strokes in recent decades, it continues to be the primary cause of mortality and morbidity in Western countries.[1] Magnetic resonance imaging (MRI) is considered the most effective modality for the detection of early signs of cerebral ischemia.[2] Diffusion-weighted imaging (DWI) is a widely utilized MRI technique that is commonly performed for the evaluation of patients affected by stroke.[3] The DWI technique has the capability to detect ischemic areas shortly after their initiation.[4] Acute arterial ischemic stroke (AIS) can be observed on DWI as a hyperintense signal after a few minutes. This is accompanied by a decrease in the apparent diffusion coefficient (ADC).[5]

The term "brain tumor" encompasses a wide range of cancers that originate from various cells within the brain (known as primary tumors) or from tumors that have spread to the brain from other parts of the body (known as metastatic tumors). Primary brain tumors encompass a variety of histologic types that exhibit diverse gross and molecular characteristics. These tumors are categorized according to the World Health Organization classification of tumors of the central nervous system (CNS).[6] Brain and other CNS tumors rank as the eighth most prevalent form of cancer among adults aged 40 and above.[7] The incidence of nonmalignant brain and other CNS tumors in adults aged 20 and above is 22.38 per 100 000, indicating that the majority of diagnosed tumors in this age group are nonmalignant, while the incidence of malignant brain and other CNS tumors is relatively low in this particular age group, with an age-adjusted incidence rate of 8.5 per 100 000.[7,8] In this retrospective study we analyzed the incidence of newly diagnosed brain tumors in diffusion MRI scans conducted in the emergency department of a tertiary care hospital in Turkey.

METHODS

In this retrospective study, we analyzed diffusion MRI examinations (GE 1.5T, 60 cm, SIGNA™ Creator/Explorer, China, 2017) with the preliminary diagnosis of acute stroke in the emergency department of a tertiary care hospital in Balıkesir in June 2023 and July 2023. Patients between the ages of 19 and 99 who presented to the emergency department were included in the study. We only utilized 2 b values (0 and 1000 s/mm^2) for DWI in this system. The typical imaging parameters were echo time = 118, 128 × 128 matrix, 260 × 260 field of view, and 7 mm section thickness. We identified patients with brain tumors on diffusion MRI images and performed basis statistical analysis. The medical histories of identified patients were scanned using the hospital data processing system and the national medical patient registry system. Patients with known primary malignancy or intracranial tumors were excluded from the study. This research has been approved by the ethical committee of Erzincan Binali Yıldırım University-kaek-2023-09-01-14572389.E1359002 (date: September 7, 2023), and the study was conducted in accordance with the Declaration of Helsinki.

RESULTS

The MRI images of a total of 1553 patients who underwent diffusion MRI for suspected acute stroke in the emergency department in June and July were analyzed retrospectively. A total of 9 patients with a primary malignancy or known intracranial mass were excluded from the study. Of 1544 patients, 841 were female and 703 were male; the mean age was 59.9. The demographic data of the patients are shown in Table 1. Among 1544 patients, 121 patients were diagnosed with acute intracranial infarction (54 females and 67 males, median age: 71), and intracranial tumors were identified in 10 patients (5 females and 5 males, median age: 59.4), and further imaging techniques were used to characterize the tumors.

On the basis of contrast-enhanced MRI examinations for tumor characterization on 3 patients diagnosed with tumors on diffusion MRI images, it was considered that the masses were predominantly compatible with metastasis (Figure 1). In the radiological imaging methods performed for primary tumor localization research, 2 of these patients were diagnosed with lung cancer and 1 with colon cancer. These diagnoses were then confirmed pathologically. On CT and MR images acquired after diffusion MRI, the masses of 2 patients primarily exhibited primary glial tumor characteristics (Figure 2). The patients underwent surgery, and their pathology results were reported as GBM.

Three patients with extra-axial mass on diffusion MR images were diagnosed with meningioma (Figure 3) with CT and MRI examinations performed after diffusion MR, and elective operation was planned by neurosurgery team. One patient had a simple cystic mass at the level of the fourth ventricle. The patient was sent to another center for surgery, but the patient's medical records could not be accessed afterward. One patient had a cystic mass reaching 5 cm in diameter in the left frontotemporal region, and a porencephalic cyst was diagnosed in conventional MRI imaging performed after diffusion MRI (Figure 4).

Table 1. Patient Demographics

Demographics	n	Mean Age
Number of diffusion-weighted images analyzed	1553	59.9
Female	846	59.7
Male	706	60.1
Number of patients with acute intracranial infarct	121	71
Female	54	71.8
Male	67	70.4
Number of patients with intracranial mass	10	59.4
Female	5	65.2
Male	5	53.6

DISCUSSION

The initial clinical application of DWI was in brain tumors. Le Bihan et al[9] published an article in 1986 describing intravoxel incoherent motion imaging, which incorporated diffusion imaging using a spin echo sequence and a 0.5 Tesla magnet. The ADC values were higher (hyperintense) in brain metastases according to low-grade astrocytomas. Moseley et al[10] published the first article on the use of DWI to detect acute cerebral ischemia in cats in 1990. Warach et al[11] reported

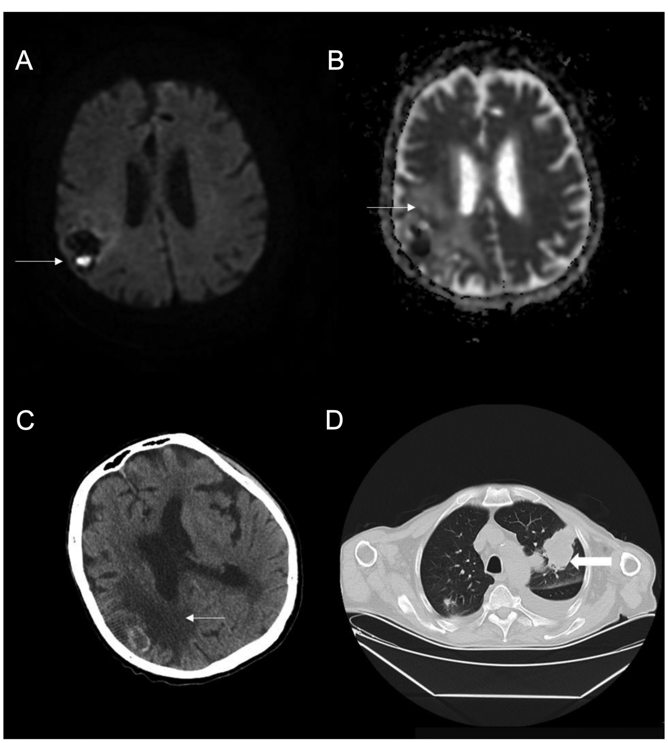

Figure 1. A 70-year-old man with intra-axial gray matter lesion in right parietal lobe. There's a focal diffusion restriction in the posterior aspect of the lesion (A, B) (arrows). Moderate perilesional vasogenic edema is seen (B, C) (arrows). Thorax CT reveals a large mass (arrow) in the upper lobe of left lung (D); pathology results confirm lung cancer in this patient. CT, computed tomography.

MAIN POINTS

- Stroke continues to be one of the primary causes of mortality and morbidity in Western countries.
- Diffusion-weighted imaging (DWI) is a widely utilized magnetic resonance imaging technique that is commonly performed for the evaluation of patients affected by stroke.
- The incidence of brain and other central nervous system tumors in adults aged 20 and above is 31 per 100 000.
- It is crucial to report other radiological findings (especially tumors) besides acute stroke on DWI images and to guide the physician about advanced radiological methods for characterization of lesions.

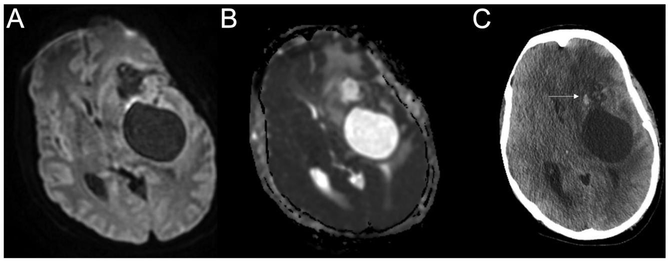

Figure 2. In diffusion-weighted and ADC MR images of a 44-year-old man, a large left temporal cystic/solid lesion with mass effect and compression of the left cerebral peduncle was detected. Solid and hemorrhagic elements on anterior margin (C) (arrow), which do not exhibit restricted diffusion (A, B). Moderate vasogenic edema more pronounced anteriorly. Pathology results confirm GBM in this patient. ADC, apparent diffusion coefficient; GBM, glioblastoma multiforme; MR, magnetic resonance.

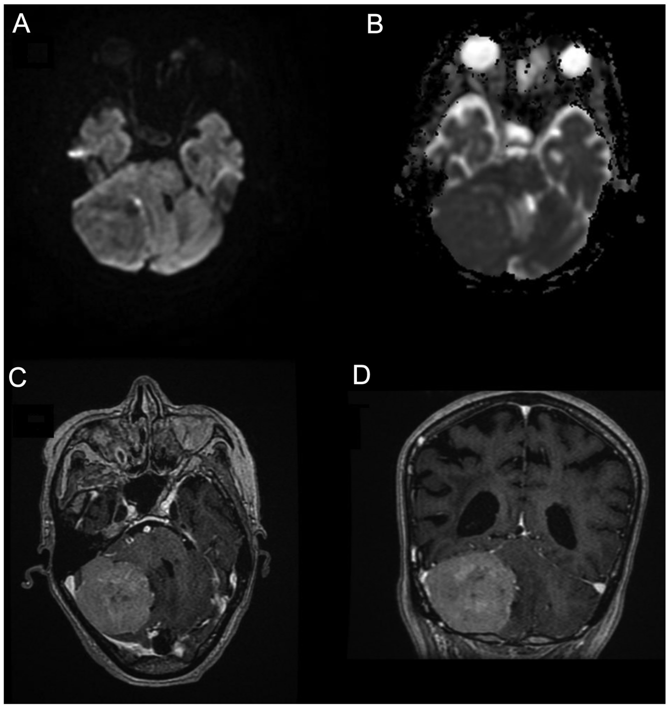

Figure 3. In diffusion-weighted and ADC MR images of a 77-year-old woman, a well-defined extra-axial mass at the right infratentorial region, measuring 5.8 cm × 4.6 cm was detected (A, B). It has a broad base to the dura. The mass also demonstrates homogeneous contrast enhancement (C, D). ADC, apparent diffusion coefficient; MR, magnetic resonance.

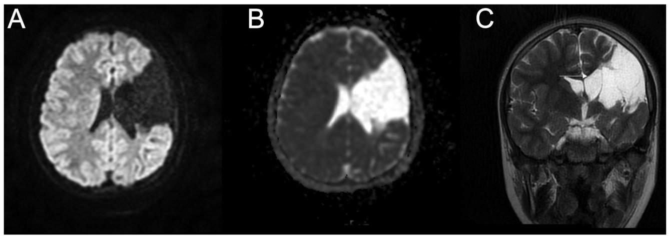

Figure 4. A large porencephalic cyst was detected in the frontotemporal region in diffusion-weighted MR images and ADC map of a 21-year-old man (A, B). Encephalic volume loss in left frontotemporal lobes evidenced by hydrocephalus ex vacuo (C) (arrow). ADC, apparent diffusion coefficient; MR, magnetic resonance.

the first clinical implementation of DWI using a 1.5 T scanner to identify patients with acute stroke in 1992.

The DWI is the most effective technique for detecting ischemic changes within the first few hours following the onset of a stroke.[12-14] It has been shown to be superior to CT at the acute stage (sensitivity 96.6% vs. 46.9%) and conventional MRI (accuracy 97.5% vs. 64.9%).[15,16] Therefore, DWI is the first-line radiological imaging method with CT for the evaluation of stroke patients in emergency departments.

Brain tumor patients may present with acute neurologic symptoms that mimic stroke. It is crucial to differentiate brain tumors from strokes as early as possible in order to avoid inappropriate treatments such as thrombolytic therapy, which carries a risk of hemorrhage, and to not delay the brain tumor's management. Magnetic resonance imaging is essential for the initial diagnosis, planning, and monitoring of brain tumors.[17] Using the T2-weighted images, fluid-attenuated inversion recovery, DWI, ADC, and T1-weighted images pre- and post-contrast MRI sequences, brain neoplasms can be readily distinguished from AIS.[18] Brain neoplasms may appear as an ovoid or round-enhancing lesion that is surrounded by vasogenic edema, which are characteristics not observed within the first few hours following the onset of a stroke.[2,17] However, when brain tumors are small, they may not exhibit all of these characteristics, making it difficult to distinguish them from infarct lesions, especially when they are seen as tumors with restricted diffusion on DWI. Variable signal intensities are exhibited by DWI for both primary and secondary tumors. Cellular density has an inverse proportion with ADC. Consequently, the ADC value of high-grade gliomas is less than that of low-grade gliomas. Similarly, lymphoma typically has a low ADC due to its high cellularity.[17-19]

In our study, we observed acute intracranial infarction in 121 patients out of 1544 DWI examinations obtained from the emergency department under suspicion of acute stroke, while 10 patients were diagnosed with intracranial mass. Upon further clinical and radiological evaluation of 3 patients suspected of having brain metastasis, lung cancer was identified in 2 patients and colon cancer in 1 patient. Three patients were diagnosed with meningioma, while 2 patients were diagnosed with GBM. A patient had a porencephalic cyst in the left frontotemporal region. In addition, a patient diagnosed with a cyst in the fourth ventricle was referred to another tertiary care hospital for surgery due to compression of the roof of the fourth ventricle.

Our study has several limitations. First, we do not have the pathology results of all patients because in our study, among the patients in whom a mass was detected, there were patients who did not have an indication for surgery. These patients were subjected to routine clinical and radiological follow-up. Second, we did not investigate age-related variables among patients with infarction and mass detected on diffusion MRI.

In conclusion, while DWI is the first imaging modality used in the evaluation of patients with suspected acute stroke in emergency department, we think that it is crucial to report other radiological findings besides acute stroke on DWI images and to guide the physician about advanced radiological methods for characterization of lesions.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Erzincan Binali Yıldırım University (Date: September 7, 2023, Number: kaek-2023-09-01-14572389.E1359002).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – E.K., E.T.; Design – E.T.; Supervision – E.K.; Resources – E.T., Ö.Ç.A.; Materials – E.T.; Data Collection and/or Processing – E.T.; Analysis and/or Interpretation – E.T., E.K., B.T.; Literature Search – E.T., Ö.Ç.A.; Writing Manuscript – E.T.; Critical Review – E.K., Ö.Ç.A.; Other – B.T.

Declaration of Interests: The authors declare that they have no competing interest.

Funding: The authors declared that this study has received no financial support.

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