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The first case of glioma detected by an artificial intelligence algorithm running on real-time data in neurosurgery: illustrative case

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BACKGROUND The aim of this paper is to report one of the significant applications of artificial intelligence (AI) and how it affects everyday clinical practice in neurosurgery. The authors present a case in which a patient was diagnosed via an AI algorithm during ongoing magnetic resonance imaging (MRI). According to this algorithm, the corresponding physicians were immediately warned, and the patient received prompt appropriate treatment.

OBSERVATIONS A 46-year-old female presenting with nonspecific headache was admitted to undergo MRI. Scanning revealed an intraparenchymal mass that was detected by an AI algorithm running on real-time patient data while the patient was still in the MRI scanner. The day after MRI, a stereotactic biopsy was performed. The pathology report confirmed an isocitrate dehydrogenase wild-type diffuse glioma. The patient was referred to the oncology department for evaluation and immediate treatment.

LESSONS This is the first report of a glioma diagnosed by an AI algorithm and a subsequent prompt operation in the literature—the first of many and an example of how AI will enhance clinical practice.

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KEYWORDS artificial intelligence; glioma; neurosurgery

Artificial intelligence (AI) technology includes deep learning and machine learning algorithms.[1,2] Like all fields, neurosurgery has become an increasing focus of research. However, AI is not yet clinically active in neurosurgery. This is the first case in the literature of a patient whose glioma was detected by an AI algorithm during ongoing magnetic resonance imaging (MRI), followed by an operation the next day at the Gazi University Faculty of Medicine Department of Neurosurgery.

The first use of AI technology in medicine was introduced into the literature by Gunn in 1976.[3] The interest in medical AI has increased in the past two decades. The search for more accurate diagnoses, safe predictions of outcomes, and rapid treatments has triggered the development of medical AI.

Neurosurgeons have always been enthusiastic about using advanced technologies, including AI.[4] For this reason, it is necessary to participate in developing AI technology. AI studies are promising, especially in the various subbranches of neurosurgery such as trauma, functional neurosurgery, and spine surgery. Although each branch has different goals and methods, all of the technological advancements share common goals, such as improving patient outcomes, helping physician decision making, and saving valuable time for both patients and healthcare workers.

Since January 2020, funded by the Presidency of the Republic of Türkiye, our institution has been the major participant of the Turkish Brain Project, which focuses on the development of AI-based brain imaging technologies. Within this project, a data set was developed to train a region-based convolutional neural network object-detection algorithm, and it is integrated into our hospital network, which processes MRI images in real time.

ABBREVIATIONS AI = artificial intelligence; CT = computed tomography; MRI = magnetic resonance imaging.

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Illustrative Case

In October 2022, this algorithm alerted our research team with a detection. A 46-year-old female patient presented with a nonspecific headache and was admitted to undergo MRI. Physicians who received the alert examined the images and detected an object that was consistent with a diffuse glioma (Fig. 1). This happened while the patient was in the MRI scanner for additional sequences. Typically, it would take days for radiology to examine and report the results. An even longer time can pass before a patient's results are evaluated. Meanwhile, the tumor can progress and cause permanent neurological deficits. Our patient was informed about the situation and admitted for a biopsy. A day later, the first patient diagnosed by an AI algorithm running on real-time data was operated on. The patient underwent a stereotactic biopsy operation. The pathology report confirmed an isocitrate dehydrogenase wild-type diffuse glioma. The patient was referred to the oncology department for evaluation and immediate treatment.

Discussion

Observations

AI applications for neurosurgical practice have gained speed in the last 5 to 10 years.[5] Lesion characterization via endoscopic or direct visualization in particular is among the most recently studied topics.[6,7] This class of applications has the ability to detect subtle changes that could elude the evaluating physician and can note patterns that may or may not be visible to the eye.[8] Radiomic studies that can predict molecular diagnoses or possible behaviors of a lesion are especially benefiting from this technology.[9] Evaluation of histopathological specimens with the aid of AI is another hot topic in this area. It has been shown that glioma classifications can be identified with a precision greater than 85%[10] or that the survival of a patient with glioblastoma can be predicted[11] from a single hematoxylin and eosin–stained specimen. Furthermore, AI has demonstrated a use even in psychological evaluations and psychotherapy.[12]

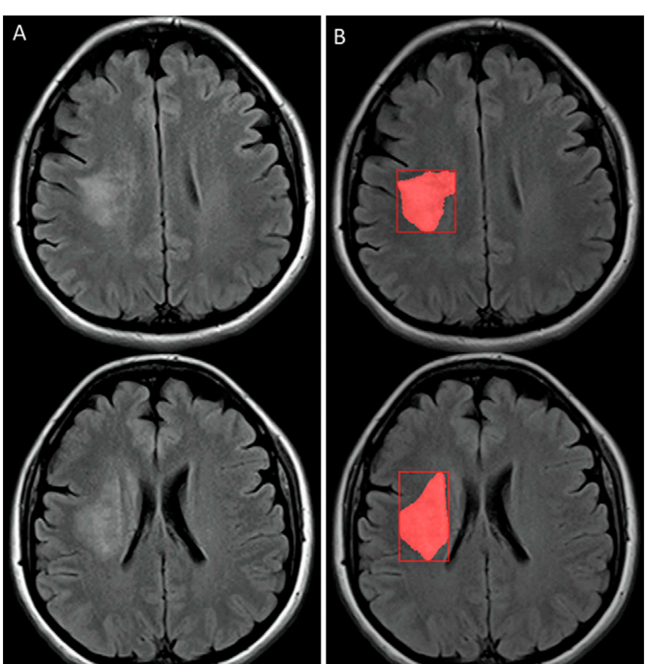

FIG. 1. Axial fluid-attenuated inversion recovery images of the patient (**A**) and segmented images generated by AI (**B**).

Radiological image evaluation for a reliable diagnosis is still in its early stages. Although many different studies have shown that a reliable neurosurgical diagnosis could be made for different scenarios, such as subdural hematoma,[13] traumatic brain injury,[14] tumor detection,[15] and classification,[16] most of these studies are experimental. There are initiatives to create open-source[17] or commercial software for automated MRI interpretation. In a literature search, there were reports on one of the commercial systems which indicates that the use of a similar computed tomography (CT)-based system reduces the scan view delay[18] as well as the hospital length of stay for pulmonary embolism and intracranial hemorrhage.[19] However, these results were obtained by comparing retrospective and prospective data, which carries the risk of unintentional bias associated with it. We were unable to identify any reports about a dedicated neurosurgical MRI processing system that is currently in use for everyday neurosurgical clinical practice in real time, such as ours. Most of these previously mentioned products are still under evaluation for neurosurgical pathologies, except for the CT-based intracranial hemorrhage triage system, and are not in active use for now. Prompt implementation of such technologies into standard clinical practice may be beneficial for patients and physicians.

Early resection is currently considered the best case management option, and early chemoradiotherapy is indicated in some cases according to the risk profile.[20] With this in mind, shortening the period from MRI acquisition to surgery is beneficial for the patients. Despite the lack of available data, relatively recent studies have suggested that the median time from radiological diagnosis to first-line treatment is approximately 3 months.[21] With the aid of this technology, we can reduce this time to days, as seen in this report. It is necessary to conduct further investigations to study the advantages of earlier treatment.

Lessons

We believe the time has come for the integration of AI in clinical practice. Alert systems such as ours will allow efficient and quick screening of complex real-life medical data. This allows an accurate and prompt prioritization of patients based on malignancy and the urgency of their diagnosis. Consequently, AI helps to save valuable time in patient care and improve healthcare quality and outcomes.

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Disclosures

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author Contributions

Conception and design: Celtikci, Borcek, Karaaslan. Acquisition of data: Celtikci, Sozer, Sagiroglu, Demirtas, Karaaslan. Analysis and interpretation of data: Celtikci, Sagiroglu, Karaaslan. Drafting the article: Celtikci, Sozer, Borcek, Sagiroglu, Poshtkouh, Demirtas. Critically revising the article: Celtikci, Borcek, Sagiroglu, Poshtkouh, Kuzucu. Reviewed submitted version of manuscript: Celtikci, Sozer, Sagiroglu, Poshtkouh, Kuzucu. Approved the final version of the manuscript on behalf of all authors: Celtikci. Statistical analysis: Celtikci. Administrative/technical/material support: Celtikci, Borcek, Karaaslan. Study supervision: Celtikci, Sagiroglu, Kuzucu.

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