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NEW HEIGHTS IN ORTHOPEDIC MEDICINE: GLOBAL IMPLEMENTATION OF ARTIFICIAL INTELLIGENCE IN MEDICAL IMAGING

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ABSTRACT

As Artificial Intelligence (AI) becomes more popular, its applications in medicine, particularly orthopedic therapy, are to be explored to improve the diagnosis process. The implementation of AI's benefits extends to a broad audience, including patients and medical professionals. Firstly, AI contributes to the diagnostic capabilities of medical imaging by significantly decreasing human error and intra and inter-observability. Additionally, AI optimizes workflow for the medical professional, mainly by automating time-staking processes to leave more time for critical analyses and patient-physician interaction. For the patient, AI can also decrease the health costs associated with medical imaging. Lastly, the fears surrounding AI replacing medical professionals are countered, saying that the application-specific nature and database limitations lend themselves to high dependency on medical professionals. In conclusion, AI should be implemented globally as a tool to improve patient care and efficiency in the medical field. This paper was written to synthesize current material on AI's benefits and limitations, ultimately to counter stigmas surrounding AI and spur further research on the topic to get closer to global implementation.

KEYWORDS: Artificial Intelligence, Deep Learning, Orthopedics, Orthopedic Surgery, Orthopedic Radiography, Medical Imaging Practice, AI

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INTRODUCTION

With the recent surge in research surrounding Artificial Intelligence and its applications worldwide, questions arise about how it impacts medical imaging—a field that has always benefited from technological advances. In orthopedic medicine, which is behind AI adoption compared to other specialties, the applications of AI in medical imaging are especially abundant and fruitful. Thus, it provokes discussion about the potential for AI in orthopedic medical imaging.

Artificial Intelligence is an umbrella term containing categories such as Machine Learning (ML) and its subcategory, Deep Learning (DL). In medical imaging, the Deep Learning algorithm is primarily used for image segmentation, image and text classification, and object detection—all needed to analyze medical data properly (Potočnik, 2023). Essentially, these deep learning algorithms enable the computer to "learn" from a data set (input by the AI engineer). This data set can include previous test results, medical images, or even patient medical records. After feeding the computer all this data, these deep learning algorithms can scan through it all, recognize complex patterns or trends, and present their findings to medical professionals—all in a short time (Maffulli, 2020). By far, deep learning has successfully analyzed medical images across various forms, such as CT scans, MRIs, X-rays, and other radiographs (Hill, 2022).

Although there is much fear surrounding AI, its applications in medical imaging prove beneficial to orthopedic medicine because it increases diagnostic capabilities, improves efficiency, and decreases costs for the patient. Therefore, it is necessary to integrate AI into medical imaging globally so that orthopedic professionals can improve the quality of patient care.

METHODOLOGY

Various electronic sources and databases were consulted to select articles relevant to the research topic. Initially, 11 sources were identified through a systematic search. After filtering for relevance to the topic, specifically orthopedic medicine and imaging, as well as the date of publication, the sources were cut down to nine. The articles with publication dates only within five years were utilized in this search in order to obtain as up-to-date information as possible while still having enough data available to analyze.

The nine articles utilized in this paper include six research papers, two articles, and one video. These credible sources were identified through Google Scholar, Google Advanced Search, and YouTube. All sources are derived from publications in various medical journals, articles from reputed medical institutions or software companies, and YouTube lecture videos from distinguished faculty in order to ensure the credibility and accuracy of the data.

RESULTS/ DISCUSSION

Diagnostic Capabilities

Clinical AI has exhibited excellent diagnostic capabilities by decreasing inaccuracies caused by human error and reducing inter and intra-observability. Throughout the medical imaging process, multiple possibilities for errors present themselves, the main types being scanning, recognition, and decision-making errors. Scanning errors occur when the radiologist or medical specialist fails to focus on the lesioned area accurately; recognition errors occur when the lesion is not detected; and decision-making errors, which constitute nearly 50% of errors, are incorrect interpretations of the lesion, such as incorrectly identifying a tumor as malignant or benign (Kimia Lab, 2020). These errors occur for multiple reasons, primarily lack of experience, time, or access to modern imaging techniques. However, with AI, this degree of error can be prevented. For instance, a deep learning algorithm called AMISS has reduced recognition errors for subtle fractures and joint instabilities in the foot and ankle by 50% and improved diagnostic accuracy to above 90%. By using complex algorithms, AI scans through each pixel of the medical image, detecting subtleties that the human eye does not see easily. This incredible technology allows physicians to go beyond the previous limits of medical imaging and gain diagnosis-changing insights. This tool transforms medical imaging, increasing diagnostic accuracy and improving patient health and satisfaction outcomes. Without this transformative technology, healthcare providers who are not experts will miss up to 20-30% of fractures (Ashkani-Esfahani, 2021). By neglecting this available technology, medical professionals risk missing pertinent patient data, which is detrimental to accurate diagnosis—the errors are amplified, resulting in misdiagnosis, which increases the risks of legal consequences for the physician and negative health consequences for the patient. To avoid these outcomes and reduce misdiagnoses worldwide, the integration of AI is necessary on a global scale.

Additionally, AI decreases intra and inter-observability—otherwise defined as the variability in imaging results caused by differing imaging protocols across operators, physicians, and institutions (Potočnik, 2023). Such variations pose significant obstacles as they lead to patient side effects, prolonged treatment, and financial burdens for the patient (Kimia Lab, 2020). More importantly, these variations cause inconsistencies in defining the scan range of anatomical areas, leading to over and under-scanning, which may cause excess radiation exposure. A safer and more favorable alternative for both the patient and physician is the integration of AI into medical imaging devices to prevent these side effects. For example, a deep learning algorithm integrated into modern CT scanners utilizes ceiling-mounted cameras to automatically position patients, detect incorrect patient positions, and warn radiographers (Potočnik, 2023). In doing so, AI completes the tedious protocols for the medical professional, enabling radiologists to focus on other facets of patient care, such as comforting, educating, and radiographing their patients. Therefore, this algorithm enables consistent, easily interpretable, reliable results across professionals and institutions and faster diagnosis. AI increases the diagnostic capabilities of medical imaging by significantly decreasing variation across clinical images. Therefore, AI is a powerful tool for orthopedic medicine to improve patient care.

Efficiency for the Medical Professional

AI can lend an efficient helping hand to medical professionals facing ever-growing workloads. Nowadays, medical professionals face the pressure of analyzing increasing numbers of medical images in a timely and flawless manner. Researchers from Massachusetts General Hospital have created an AI system called OSAIRIS to streamline segmentation, the process of manually outlining healthy tissue around a cancerous region to protect it from radiation. This meticulous task, which can take the physician from 20 minutes to three hours per patient, can be automated with OSAIRIS, speeding up the treatment process by two and a half times (Rizi-Shorvon, 2023). With the number of patients to attend to, the time for manual segmentation is too time-consuming for physicians—their time is better spent on analyzing patient results, planning treatment, and patient education. By enabling better use of physicians' time, AI can transform physician and patient care so that more time and emphasis are placed on the diagnosis and treatment of patients. By coupling this with scan time-reducing AI algorithms such as Deep Resolve, scan times can be reduced by 70% and fully optimize the diagnosis process (Potočnik, 2023). Providing these resources to physicians and other medical specialists will reduce exacting tasks, leave time for proper patient-physician interaction, and combat burnout rates throughout healthcare while concurrently meeting the demands for medical imaging. Thus, implementing AI in medical imaging has significant potential for orthopedic medicine.

Decreased Costs for the Patient

Using AI in medical imaging benefits patients by significantly decreasing their health, financial, and time costs. In response to the high levels of radiation exposure from regular CT scans, True Fidelity, a DL-based image reconstruction technique, was developed to facilitate high-quality CT images from low radiation doses (Leeuwen, 2021). Another method of AI-enabled fluoroscopy has enabled automatic and accurate collimation, resulting in more than 60% reductions in radiation dose in patients (Potočnik, 2023). This technology is transformative given that radiation reduction is a critical goal for radiology and cancer treatment, as radiation directly impacts patient survival and quality of life. Furthermore, this reduction in dosage is especially beneficial for pediatric patients, whose chances of cancer are elevated with each radiation dose.

Additionally, long MRI scan times give rise to DL image reconstruction techniques by GE and Phillips, which have accelerated scan times by up to 50% and 66%, respectively (Ashkani-Esfahani, 2021). This reduced time has the potential for faster diagnosis, a reduction in global CT and MRI waiting list burdens and mortality rates, and lower healthcare and medical imaging costs for the patient. Moreover, with these higher-quality images, the need for repeat radiographs is eliminated, decreasing the time needed for diagnosis and the costs of care for patients. Thus, these AI-based advances are monumental to medical imaging—from decreasing the risks of radiation in patients of all ages to decreasing healthcare costs and saving patients' valuable time—these applications are necessary for healthcare globally.

Fear Surrounding the Implementation of AI

With the advent of AI, there is much speculation and even fear about AI taking over physician and radiologist jobs. However, due to the internal structure of the AI algorithm and the scope of human disease, there are limitations to AI that can only be made up for by medical professionals. The internal architecture of AI is composed of artificial neural networks. This network comprises layers of mathematical functions whose inputs come from the medical image provided and whose outputs are given after running through those mathematical functions (Hill, 2022). In other words, the inputs, or the medical data provided, determine what AI can and cannot see. Therefore, AI is only as good as its dataset, while medical professionals use a variety of experiences and knowledge such as patient opinion, insurance issues, and patient fit for specific treatments. Therefore, the medical professional continues to hold the upper hand in medicine, demonstrating that they cannot be replaced.

Furthermore, AI is only application-specific, capable of diagnosing a single or small set of diseases. In contrast, radiologists possess a more comprehensive range of knowledge, enabling them to diagnose and interpret a variety of conditions. Hence, since AI is far beyond the scope of radiologists, it demonstrates the importance of medical professionals. AI is also incapable of diagnosing rare diseases. For AI models to be trained appropriately, large datasets are needed for high accuracy of results (Chen, 2022). However, due to the shortage of medical images and materials for rare diseases, there is simply no way for AI to diagnose them. In the end, although AI can be helpful, it has its limits, proving that AI is only a tool for medical professionals to use in the diagnosis process. As always, medical professionals will stand at the forefront of medicine, never to be replaced.

CONCLUSION

To augment patient care, clinical AI must be integrated into medical imaging globally. Although many people fear that integrating AI will replace medical professionals, this fear is unjustified due to AI's purpose as a tool for the medical profession's use. This tool serves to enhance diagnostic capabilities by decreasing human error and intra and inter-observability, decreasing medical professionals' workloads, and reducing the financial and health costs of medical imaging for patients. Consequently, researchers and physicians should push forward with the global integration of AI, as it will enhance patient care in orthopedic medicine to an unprecedented degree.

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