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Concept of Artificial Intelligence (AI) and Its Use in Orthopaedic Practice: Applications and Pitfalls: A Narrative Review

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Abstract

Background: The growth and use of Artificial Intelligence (AI) in the medical field is rapidly rising. AI is exhibiting a practical tool in the healthcare industry in patient care. The objective of this current review is to assess and analyze the use of AI and its use in orthopedic practice, as well as its applications, limitations, and pitfalls. **Methods:** A review of all relevant databases such as EMBASE, Cochrane Database of Systematic Reviews, MEDLINE, Science Citation Index, Scopus, and Web of Science with keywords of AI, orthopedic surgery, applications, and drawbacks. All related articles on AI and orthopaedic practice were reviewed. A total of 3210 articles were included in the review. **Results:** The data from 351 studies were analyzed where in orthopedic surgery. AI is being used for diagnostic procedures, radiological diagnosis, models of clinical care, and utilization of hospital and bed resources. AI has also taken a chunk of share in assisted robotic orthopaedic surgery. **Conclusions:** AI has now become part of the orthopedic practice and will further increase its stake in the healthcare industry. Nonetheless, clinicians should remain aware of AI's serious limitations and pitfalls and consider the drawbacks and errors in its use.

Keywords

Artificial Intelligence, Healthcare, Pitfalls, Drawbacks

1. Introduction

Orthopaedic trauma is an injury to the musculoskeletal system which is caused by an external force. Such injuries are the result of road traffic accidents, sports injuries, falls from ground level and from heights. As per the World Health Organization (WHO), it is estimated that 1.71 billion patients suffer from musculoskeletal problems worldwide [1], with 5 million deaths and 16% of the world's burden of disease [2]. With the enormous number of patients requiring care, mistakes are committed more often. Law suits due to malpractice related to orthopaedic surgeons are common and at least 10 times more than other specialties [3] [4].

AI came into the public domain in 1997 when IBM's Deep Blue computer defeated world chess champion and grand master Gary Kasparov using a chess-playing computer program. This gave a major push for further research and development in AI. Initially, AI was implemented in banks, the pharmaceutical industry, and the insurance market to reduce the time needed to analyze big data sets. In a 2018 survey of 1100 US companies on AI, 63% showed that they were using AI in their business activities [5].

AI was wholeheartedly adopted in healthcare with the belief that it would help in clinical decision-making and analyzing large amounts of data, without realizing there are mistakes that can be made which can end up in legal perils. This article looks into the benefits and pitfalls of the routine use of AI in medical practice.

2. What Is Artificial Intelligence (AI)

Artificial intelligence works in a way that pretends human actions utilizing machines, computers, and software. Using AI, many functions and tasks performed by humans can be replicated by computers and their software. In a nutshell, AI is a branch of computer science that creates machines that can think and make decisions on their own without human intercession. AI algorithms make the machines react based on the tremendous amount of data input and make predictions.

There are four types of AI and three significant kinds of AI algorithms. The types of AI are Reactive machines, Limited memory, Theory of mind and Self-awareness and each type is based on how much data can be stored and how the data is used. The main algorithms are supervised learning, unsupervised learning, and reinforcement learning.

3. How Does AI Work?

The common computer languages used are Python, R, Java, C++, and Julia, which have features popular with AI developers [6]. In general, AI systems work by ingesting large amounts of labeled training data, analyzing the data for correlations and patterns, and using these patterns to make predictions about future states. New, rapidly improving generative AI techniques can create realistic text, images, music, and other media.

AI programming focuses on cognitive skills that include the following:

Learning, reasoning, creativity, and self-correction: AI systems and programming are upgraded on a regular basis so that they provide the most correct and precise results [7]. AI, machine learning (ML), and deep learning (DL) are related but different and easily distinguishable. Artificial Intelligence: replicates human Intelligence in machines and includes machine learning and deep learning as part of its proficiency.

Machine learning (ML) allows the software to envision outcomes. The large data-infused will help the ML make accurate predictions effectively.

Deep learning (DL), a subset of machine learning, is inspired by how the brain works. It uses artificial neural networks and is behind advancements like self-driving cars and ChatGPT.

Neural Networks: A neural network is a method in artificial Intelligence that teaches computers to process data in a way that is inspired by the human brain. It is a machine learning process, called deep learning that uses interconnected nodes or neurons in a layered structure that resembles the human brain.

4. AI in Healthcare

The ever-expanding AI was embraced by healthcare to assist medical professionals in providing patient care 24 hours a day. Added to the routine activities, AI was put to the test in identifying medical images, radiographs, making a diagnosis and initiating treatment plans. The most complex forms of machine learning involve deep learning or neural network models with many levels of features or variables that predict outcomes. A common application of deep learning in healthcare is the recognition of potentially cancerous lesions in radiology images.8 Deep learning is increasingly being applied to radionics, or the detection of clinically relevant features in imaging data beyond what can be perceived by the human eye [8]. Both radiomics and deep learning are most commonly found in oncology-oriented image analysis. Their combination appears to promise greater accuracy in diagnosis than the previous generation of automated tools for image analysis, known as computer-aided detection (CAD).

5. AI and Orthopaedic Surgery

In the last few years, there has been an outpouring of research in the domain of AI for image recognition, diagnosis of fractures, implant positioning, tumor detection, Osteoarthritis detection and prediction, and imaging of bone and cartilage were the most studied topics, and some congenital diseases. Machine learning (ML), Deep learning (DL), and convolutional neural networks (CNNs) require human supervision to learn and be modified as per the requirement of a particular center.

Langerhuizen *et al.* (2019) [9] reported that fracture recognition by AI is as good as human performance. When classifying proximal humerus fractures, often incorrectly diagnosed due to varied presentation, a CNN outperformed general physicians and general orthopedic surgeons, but the results were similar to the surgeons holding fellowships in the upper extremities. The data available to CNN to assess to make a diagnosis was ~2000 radiographs classified according to the Neer classification [9]. There are few reported studies that found the AI was at par with the human level. On the other hand, the accuracy of AI was 83%

when injuries of wrist, hand, ankle and foot injuries were analysed [10] [11] [12] [13]. This analysis was only simple and straightforward fractures. Another type of fracture is scaphoid fractures, where the radiographs, even seen by hand surgeons, are unable to correctly diagnose radiographically occult fractures. When CNN was tested to identify scaphoid fractures that were radiographically invisible to radiologists, CNN did not outperform them [14]. AI has also shown promising results in several other diagnostic applications, ranging from developmental abnormalities to soft-tissue knee injuries. A proof-of-concept investigation by Xie *et al.* (2021) [15] tested a CNN-based algorithm to improve the quality of MRI scans in tibial plateau fractures with combined meniscal defects [16]. The authors documented a sensitivity of 96.9%, specificity of 93.2%, and accuracy of 95.3%, respectively, when MRI diagnostics were compared with arthroscopic findings. The clearer, enhanced AI imaging produced by the CNN model led to a diagnosis that was consistent with intraoperative findings. Regarding congenital abnormalities, such as hip dysplasia, studies have also shown practicalities for radiological measurements in a quick and effective manner [17]. AI-assisted diagnosis and classification of OA from radiographs have demonstrated similar accuracy to senior clinicians [18]. Furthermore, CNNs for osteoporosis fracture recognition have been developed to directly evaluate bone mineral density from radiographs [19] [20]. AI image recognition may soon be a highly sought-after application in orthopedics, corroborated in a study by Jang *et al.* [21] where CNNs were reported to identify bone and soft-tissue landmarks as objects on radiographs. Additionally, more accurate calculations using the DL model for knee alignment may provide the potential for preoperative planning in total knee arthroplasty (TKA) [21]. However, several limitations such as the established ground truths, radiograph quality, alignment, or rotation indicate the variability and, as such, these methods are not yet employed in preoperative planning for TKA [21].

A recent scoping review by Gurung *et al.* (2022) [22] investigated the application of AI in analyzing postoperative radio-graphs following total hip arthroplasty (THA) and TKA to ensure adequate implant positioning and reported > 90% accuracy. While the 12 individual studies were large, using up to 320,000 radiographs, their robustness was a point of contention. Gurung *et al.* (2022) [22] concluded that, at the present time, there is inadequate evidence to use AI for said purposes in clinical practice. Borjali *et al.* (2022) [23] assessed a novel, highly accurate, and fully automatic approach identifying to the design of THA prostheses from plain radiographs. An AI model able to identify prostheses within milliseconds, versus 20 to 30 minutes, can have huge implications for patient safety [23]. Furthermore, it has been shown that in 10% of cases, surgeons are unable to identify the prosthesis preoperatively and in 2% intraoperatively.

6. Drawbacks and Pitfalls in AI

6.1. Ethical Concerns

The use of AI in healthcare has raised ethical issues since it was initially created and brought into use. The issues raised were accountability, data privacy, surveillance, bias, and discrimination. Because of the gravity of the issues, the system needs authority to be accountable when it makes incorrect and improper decisions, especially in the healthcare field. Many researchers are worried that there are no guard rails on conclusions made by the AI algorithms. In situations of inappropriate decisions, the ultimate responsibility becomes more important, but the AI does not identify who will be responsible except to blame event system failure. Many authorities believe that once the technology is in use, then there is always a risk of infringement and data breaches, and mistakes in healthcare can have catastrophic reverberation for patients. As there is no clear-cut policy of responsibility on the legal and ethical issues in the use of AI in healthcare, this is an important arena that needs to be further investigated. Hospital administrators need to be sure that these ethical issues are addressed proactively so that the benefit of AI outweighs the risks. On the other side, many believe that AI should be on hold till the ethical issues are addressed completely. The use of artificial Intelligence for ethical decision-making in healthcare is prohibited in China [24] [25].

6.2. Data Gathering Concern

The first issue is the unprocurable relevant data so that machines can use it. Enormous datasets are required for ML and DL models to correctly predict diseases. The healthcare line of work has a compounded issue in accessing patients' data [26], as this is labelled as confidential in the light of patients and legal light and many institutions are unhappy to provide the data. Unless before the patients are treated, informed consent is taken to share the data for the betterment of other patients. This would help ML-based systems to continuously improve as more data were added to their training set. It has been stated that the effective inception of AI in routine healthcare use requires a paradigm shift from treating patients individually to improving healthcare. Institutions are also afraid to implement AI-based systems and are concerned about data security and privacy, as important data can be hacked during data breaches [27]. Many countries are passing laws on how AI and data sharing should be used, and restrictions apply, this makes universal collaboration and cooperative research more difficult and will limit the quality and quantity of data accessible to train AI systems on an international scale [28].

7. AI and Pit Falls

In today's quickly advancing technological topography, AI is making revolutionary changes in the scientific world. One such arena where AI is showing enormous convenience is healthcare. It has this promise to improve patient care, diagnosis, and treatment outcomes. But this type of technology, which is disruptive, can go from being extremely intelligent to extremely naive in an instant. Some AI systems will inevitably fail to perform, and the Pitfalls are many that need to be addressed before we take AI into our day-to-day healthcare practices. Based on prior Orthopaedic In-Training Examination testing, recently it was shown that a new AI model using large language models (LLM), ChatGPT (OpenAI), was able to select the correct answer way below 47% [29]. This confirms that AI may not be 100% correct in important situations which may harm patients more than it can benefit them. It is to be understood that AI is created by humans and not vice versa; hence, it cannot replace the human empathy and care that patients require during illnesses, apart from improper use of patients' data and the surrounding security breaches which will bother patients including identity theft that can have worse consequences. It is also to be kept in mind that AI algorithms are only as good as far as the data that is available to be trained. Suppose the training data is limited to the Western world, which will be biased if one wishes to extract the healthcare outcomes in Asian countries. Hence, the AI in different regions of the world will depend on their patient data. If AI fails to make a correct diagnosis or treatment, who will be responsible for the healthcare providers who use it, or will the technologists be accountable for the system they developed and marketed? As there are many parties involved in an AI system (data provider, designer, manufacturer, programmer, developer, user, and AI system itself), liability is difficult to establish when something goes wrong, and there are many factors to be taken into consideration. Ultimately, liability for negligence would lie with the person, persons, or entities who caused the damage or defector who might have foreseen the product being used in the way that it was used. In the event that the damage results from behaviors by the AI system that were wholly unforeseeable, this could be problematic for negligence claims, as a lack of foreseeability could result in nobody at all being liable.

There is a scarcity of literature in this regard, and a frame of reference needs to be studied and implemented by the highest bodies of legal minds and policymakers to make proper guidelines and legal and moral responsibility. In the absence of legislation relating to AI, redress for victims who have suffered damage as a result of a failure of AI would most likely be sought under the tort of negligence.

8. Conclusions and Future Considerations

The inception of AI in orthopedics has the potential to get better for orthopedic patient care in the months to come, which will share the workload of healthcare professionals. The benefits of AI will revolutionize the way orthopedic surgeons will work in the future. Early and correct diagnosis of malignancies and difficult fractures, pinpoints the correct positioning of hip and knee implants, particularly in revision surgeries, identifies loosening of implants, and predicts the final functional outcomes. To achieve all the facets mentioned above, AI systems must be robustly evaluated and validated. It is paramount to establish tests and assess dependability, performance, and safety. AI is going to be increasingly used in healthcare and hence needs to be morally accountable.

Data bias needs to be avoided by using appropriate algorithms based on unbiased real-time data. Diverse and inclusive programming groups and frequent audits of the algorithm, including its implementation in a system, must be carried out. While AI may not be able to completely replace clinical judgment, it can help clinicians make better decisions. If there is a lack of medical competence in a context with limited resources, AI could be utilized to conduct screening and evaluation. In contrast to human decision-making, all AI judgments, even the quickest, are systematic since algorithms are involved. As a result, even if activities don't have legal repercussions (because efficient legal frameworks haven't been developed yet), they always lead to accountability, not by the machine, but by the people who built it and the people who utilize it. While there are moral dilemmas in the use of AI, it is likely to meager, co-exist, or replace current systems, starting the healthcare age of Artificial Intelligence, and not using AI is also possibly unscientific and unethical.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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