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Artificial intelligence and orthopaedics

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ABSTRACT

Artificial intelligence is the next big thing in human history. It is set to affect large and small industries, entertainment, agriculture, literature, research, and healthcare. The field of Artificial intelligence includes machine learning and deep learning, which denote an increased level of specialization. These changes are also set to influence orthopedic trauma, from diagnostics, clinical assessment, surgical intervention, rehabilitation, and outcome prediction. Some of these fields will be affected more than others. We carried out a narrative review of artificial intelligence and orthopaedic surgery to provide an updated overview of the current and future applications. AI is set to revolutionize radiological diagnostics, outcome measurement, and rehabilitation in orthopedic trauma. However, concerns about clinical decision-making and intervention remain. Ethical concerns, regulation, and superiority over traditional methods of treatment also need to be assessed. Until then, the role of AI in orthopaedic trauma remains in the realm of possibilities.

Keywords: Artificial intelligence, Orthopaedics, AI

INTRODUCTION

A clinician evolves over a lifetime in the fields of disease diagnosis, clinical decision-making, and outcome prediction.[1] The quest is permanent as research uncovers newer facts every day. Even as it becomes impossible for an individual human brain to keep pace with the massive amounts of developing research data, artificial intelligence is making it possible to sort and assess data at unimaginable speeds. Artificial intelligence (AI), machine learning (ML), and deep learning (DL) are being rapidly adopted in industry and science.[1] This adoption is underpinned by the fact that 21st-century science has ensured that data is gold.[2] This is closely tied to improved computing power, cloud-based computing and development, and the development of medical task-specific software algorithms.[2] Conventional thinking would suggest that AI should increase healthcare delivery, improve indications and interventions, and minimize errors. However, clinical medicine does present some barriers unique to the field of human health. These include ethical concerns, research biases, and a lack of uniformity and consensus among health professionals. Even as AI heralds a new revolution, there is a mix of apprehension, concern, cynicism, and hope among medical professionals. The purpose of this review is to have a look at the current literature and assess the current and future role of AI in orthopaedic surgery.

We used a Boolean query to search Pubmed, Central, EMBASE, and Ovid for the terms orthopaedic trauma and artificial intelligence. There were 991 results. As artificial intelligence is a rapidly evolving branch, we considered papers published in the last 3 years only (2022-2024). This reduced the search to 400 papers. All authors participated

in reading the abstracts of the papers. Papers discussing the same type of surgery with respect to artificial intelligence were excluded. Papers that did not discuss orthopedic trauma were also excluded. Papers comparing various AI models were also excluded. This narrowed the search to 31 papers. A review of these manuscripts is presented below.

DISCUSSION

John McCarthy first used the term Artificial Intelligence. The term, therefore, is not entirely new. AI is data-based and entirely reliant on inputs. One of its subsets, machine learning (ML), a field where machines can make decisions, represents a more intriguing future that could impact the field of medicine significantly.[3]

Artificial intelligence's (AI) accelerating progress demands rigorous evaluation standards to ensure safe, effective integration into healthcare's high-stakes decisions. As AI increasingly enables prediction, analysis, and judgment capabilities relevant to medicine, proper evaluation and interpretation are indispensable. Erroneous AI could endanger patients thus, developing, validating and deploying medical AI demands adhering to strict, transparent standards centre on safety, ethics and responsible oversight.[4]

AI can be supervised, where data is fed into the system, and predictable decision-making is witnessed. It can also be unsupervised, which is relatively unpredictable. However, this type of AI does not have inherent human biases. The unsupervised type is also known as deep learning.[5] We will examine the present status of AI in orthopedic surgery under several subheadings, which will help us understand its status in disease diagnosis, clinical decision-making, and outcome prediction.

Automated diagnosis

This is a field that is expected to benefit a lot as AI evolves in the near future. Liu et al in their study in 2024 found that the YOLOX-SwinT network algorithm enhances the accuracy of AO/OTA subgroups classification of ITF by orthopedic trauma surgeons.[6] Bhatnagar et al mentioned that among the most prevalent causes of inaccurate diagnosis and medical lawsuits is the overlooked fracture on radiographs taken in the emergency room, which can range from 2% to 9%. The workforce will soon be under a great deal of strain due to the growing demand for fracture detection on multiple imaging modalities. AI, according to them, can overcome this issue.[7]

DellAria et al, in an interesting study, found that AI performed better than the radiologists in detecting common fractures, but not subtle fractures.[8] In a study in 2024, Yuh et al, concluded that deep learning-assisted measurement is expected to expedite the diagnostic process and enhance reliability, particularly benefiting less experienced clinicians.[9] Deep learning models can identify implants before hardware removal. This information is lacking in 10 percent of cases where implant removal is planned, causing problems during the procedure. Obviously, prior knowledge can be of help in such situations.[10]

Radiological imaging is central to the establishment of orthopedic diagnosis. Current studies with AI show that the diagnosis rates tend to approach expert levels with AI. However, AI will be used more widely if it can reduce radiology time and interpretation time, lower misinterpretation, improve patient outcomes, and reduce complication rates.[11]

Fracture fixation

Zhao et al used TiRobot assisted F screw technique and inverted triangle parallel nail internal fixation in the treatment of unstable femoral neck fractures. They found that the percutaneous cannulated F screw technique using Tirobot navigation positioning system is a safe and effective treatment for patients with unstable femoral neck fractures.[12] Jiang et al compared femoral neck fixation with and without AI assistance. AI assisted surgery showed less fluoroscopy times, guide needle drilling times, hollow screw replacement times, and intraoperative bleeding volume. All other parameters remained comparable.[13]

Rakhshankah et al, concluded their manuscript on avascular necrosis of the femoral head. The ability of AI to achieve high accuracy with remarkable efficiency makes it promising for early detection and intervention, ultimately contributing to improved patient outcomes.[14] Paik et al, studied vertebral compression fractures. Their main focus was detection. They concluded that their model could be a potential tool for detecting VCFs from a simple radiograph and assisting doctors in making appropriate decisions in initial diagnosis.[15] Preoperative planning of implants aided by AI can streamline surgeon workflow.[16]

Outcome prediction

Several models have been tested for outcome prediction including Support Vector Machine [SVM], Least Absolute Shrinkage and Selection Operator [LASSO] and random forest.[17] Nijhuis et al, used AI models to detect and classify distal end radius fractures. They rated the ability of AI as ‘promising’. However, they were unable to detect any algorithm that could predict loss of alignment.[18]

Knee et al. conducted a similar study and concluded that Chat GPT has significant limitations and is of limited use in its current format.[19] Silva et al, made a similar observation regarding the use of AI for outcome prediction in femoral neck fractures. They felt that AI was in its infancy.[20] Yao et al, used a Python-based extraction tool to make an automatic diagnosis of supracondylar fractures. They concluded that the method had potential.[21] Perhaps Kaspovic et al, reached a reasonable conclusion regarding the current status of AI in orthopedic trauma. They

mentioned that while AI-based language models like ChatGPT hold significant promise for medical education and patient care, the current quality of information provided in orthopedics and trauma surgery is suboptimal. Further development and refinement of AI sources and algorithms are necessary to improve the accuracy and reliability of medical information.[22]

However, Kaarre et al, praised the ability of Chat GPT for its correctness, completeness, and adaptiveness. The adaptiveness is perhaps something that could change the current consensus over a period of time.[23]

Complication prediction

Dai et al, studied the prediction capability of AI in elderly patients for the development of post-operative comorbidity. This is an area that could see early implementation in the future.[24] Whiteside et al used AI as a predictor. They felt that an artificial intelligence algorithm that analyzes the pulse oximeter waveform in the fingertip can be used to determine the compensatory reserve index (CRI) in trauma patients. Thus, one can identify patients at risk for transfusion and the need for urgent medical care and may aid in the management of blood loss and transfusion in major orthopedic surgery.[25] Naranjo et al, used AI similarly to predict surgical site infections. They felt that more data is required to make the predictive power more reliable.[26]

Length of hospital stay

Lai et al, showed that AI models could predict the length of hospital stay with fair accuracy.[27] Youssef et al, recommended AI for data-driven, personalized patient care, strengthening patients' self-responsibility and supporting interdisciplinary healthcare in orthopaedic trauma.[28]

Preventive medicine

Shariatzadeh et al, developed models which they felt could serve as reliable screening tools to assess the risk of distal radial fracture in the general population before bone mineral density testing. In addition, they can be integrated into decision support systems to help healthcare providers identify high-risk patients for additional evaluation and education.[29] Chalhoub et al, concluded that ChatGPT falls short in providing reliable management recommendations, with a 30% misdiagnosis rate and 53% mismanagement rate in our study. Its limitations, including reliance on outdated data and the inability to interactively gather patient information, must be acknowledged.[30]

Is it time to store and update personal data?

AI has the capacity to create and maintain individual data sets. As an example, healthy patients can regularly update their gait analysis, bone density, body mass index, baseline radiographs and hematology and serology. All these could factor into fracture management if there is a subsequent injury. Farhadi et al, put it beautifully when they divided future areas into two groups. Areas of interpretive uncertainty, and areas of substantial time and resource consumption. Both areas need separate AI application modules, with the former needing a strong ethical debate.[1] Lex JR et al, wrote that complicated, uninterpretable models may not provide benefit over traditional, interpretable models for patient specific outcome prediction.[31]

CONCLUSION

While AI is set to change radiology, outcome prediction, and rehabilitation, its use on a broader scale in the management of orthopedic injuries is still not possible. One obstacle to this end is the problem of data acquisition. Data security, legal issues, data heterogeneity, and ethics have to be debated and discussed before further progress can be made in this regard.

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