https://doi.org/10.5272/jimab.2024304.5786

Journal of IMAB
ISSN: 1312-773X
https://www.journal-imab-bg.org

Journal of IMAB. 2024 Oct-Dec;30(4)

Review article

THE ROLE POTENTIAL OF ARTIFICIAL INTELLIGENCE IN KNEE OSTEOARTHRITIS

Petya Subeva, Mariya Gramatikova
Department of Kinesitherapy, Faculty of Public Health, Healthcare and Sports, South-West University "Neofit Rilski" Blagoevgrad, Bulgaria.

SUMMARY

Purpose: The purpose of the study is to examine available scientific sources related to the role and potential of artificial intelligence in osteoarthritis of the knee joint.

Materials/Methods: Method of deduction (analysis of literary sources). To achieve the goal, available scientific data on the role and potential of artificial intelligence application in knee OA were studied and analyzed.

Results: The following innovations related to the use of artificial intelligence in knee osteoarthritis (OA) were reviewed: artificial intelligence (AI) software - named KOALA™ and DL AI software - MediAI-OA. KOALA™ is software that provides metric evaluations of knee joint imaging. Standardized quantitative measurements of morphological features such as joint gap width and joint gap area on knee radiographs reduce errors in diagnosis. The new DL software, MediAI-OA, demonstrated good success rates in analyzing knee OA characteristics, Kellgren-Lawrence (KL) grading (which is used to classify the severity of knee OA), and OA diagnosis comparable to that of experienced orthopedists and radiologists.

Discussion: Diagnostic imaging is a vital tool for visualization. Imaging methods such as radiography, magnetic resonance (MR), computed tomography (CT), and ultrasound play critical roles in OA diagnosis. Additionally, vibro- and phono arthrography serve as alternative diagnostic tools. The most commonly used imaging method is magnetic resonance imaging, which has been found to underestimate the extent of osteochondral lesions. This can lead to inadequate and incomplete diagnoses. Artificial intelligence can serve as a strategic element in addressing these limitations in radiographic knee OA diagnosis.

Conclusion: Artificial intelligence has the potential to advance the field of radiology by enhancing efficiency, accuracy, and precision in the radiographic diagnosis of knee osteoarthritis.

Keywords: Artificial Intelligence, Osteoarthritis (OA), Knee Joint, Gonarthrosis, Software,

INTRODUCTION:

The term Artificial Intelligence (AI) was introduced by John McCarthy, and research in the field of AI began in the 1940s and 1950s [1]. The modern theoretical foundation for AI was first introduced in 1950 by Alan Turing [2].

Artificial Intelligence (AI) is one of the most discussed topics today. AI has the potential to enable greater coordination and integration between humans and technologies [3]. In times of constantly evolving technologies, there is increasing interest in the applications of artificial intelligence (AI) in the field of medicine. This is due to the emergence of algorithms for deep learning, advances in computer hardware, and the exponential growth of data generated and used for clinical decision-making [4].

AI has the potential to bring about changes in the way diagnoses are made, treatments are conducted, and healthcare processes are managed as a whole. The use of AI can shorten the time to solve health problems and facilitate the work of medical personnel. It can also track health trends, predict disease development, and improve treatment plans for better patient outcomes.

To achieve more accurate diagnoses of diseases and make more appropriate choices for their therapy, algorithms and machine learning are used on massive amounts of data related to patients and health conditions. This reduces the likelihood of errors in diagnosis.

Despite all the positive aspects, there are also some challenges in implementing AI in medicine, such as data security and ethical issues. Nevertheless, its role in medicine is emerging as key to the future of healthcare and may change the way we understand and treat diseases.

Knee osteoarthritis (OA) is a leading cause of severe disability, with an increased prevalence among the elderly. It has social significance, as a large percentage of those affected are of working age. This degenerative joint disease is associated with pain, stiffness, decreased mobility, abnormal gait, discomfort, limited functional

abilities, and others. Early, accurate, and precise diagnosis is crucial for preventing disease progression and optimizing treatment regimens [5].

OA is characterized by pathological changes in cartilage, ligaments, synovium, muscles, and periarticular fat tissue [6].

AI can help with faster and more accurate diagnosis of knee osteoarthritis through analysis of medical data and images. With its assistance, it is possible to personalize individual treatment approaches, taking into account the unique characteristics and peculiarities of each patient. Machine learning algorithms can analyze data on surgical procedures, medications, physiotherapy and propose an optimal treatment plan.

AI can also be useful for monitoring treatment effectiveness and predicting the risk of future osteoarthritic flare-ups. This can help both patients and doctors make better decisions to manage the disease.

Artificial intelligence can significantly contribute to better treatment of knee osteoarthritis by providing valuable tools and solutions for personalized patient care.

MATERIALS/METHODS

Objective: The aim of the study is to investigate available scientific sources related to research on the role and potential of artificial intelligence in knee osteoarthritis.

Research Methods:

1. Deductive method (analysis of literary sources).

To achieve the goal, available scientific data on the role and potential application of artificial intelligence in knee osteoarthritis were examined and analyzed.

RESULTS

The following innovations related to the use of artificial intelligence in knee osteoarthritis (OA) were reviewed: artificial intelligence (AI) software - named KOALA™ and DL AI software - MediAI-OA. KOALA™ is a software that provides metric evaluations of anterior-posterior or knee radiographs. Standardized quantitative measurements of morphological features such as joint gap width and joint gap area on knee radiographs reduce errors in diagnosis [7]. The applied AI software is based on a large dataset of 20,000 individual knee radiographs. KOALA™ combines several low and high-level modules, where the low-level modules are responsible for knee joint recognition and orientation. The information obtained is transferred to the high-level modules, which are responsible for joint segmentation and measurement to classify the severity of knee OA [7].

The new DL software, MediAI-OA, demonstrates good performance in analyzing knee OA characteristics, grading on the Kellgren-Lawrence (KL) scale (which is used to classify the severity of knee OA), and diagnosing OA, comparable to that of experienced orthopedists and radiologists. The MediAI-OA approach consists of several steps: (1) detection of the knee joint area and areas associated with osteophytes; (2) quantitative analysis and segmentation of joint gap width; (3) determination of the presence of osteophytes in all areas; (4) automatic classification according to the Kellgren-Lawrence (KL) scale for knee OA severity; (5) integration and visualization of OA characteristics [8].

The Kellgren-Lawrence (KL) classification system is the most widely used method for grading the severity of knee osteoarthritis (OA). However, due to terminology ambiguity, the KL system has shown lower reliability. MediAI-OA is a newly developed software designed to provide a more reliable assessment and extraction of each radiographic characteristic of knee OA, as well as grading the severity of OA based on the KL system. [8].

In a study by Yoon JS. et al. (2023) [8], data from the osteoarthritis initiative were used for training and validating MediAI-OA. 44,193 radiographs and 810 knee radiographs were designated as training data and used as validation data, respectively. This AI model is developed for quantitatively assessing the degree of narrowing of the joint space in the medial and lateral tibiofemoral joint for automatic detection of osteophytes in four areas (medial distal femur, lateral distal femur, medial proximal tibia, and lateral proximal tibia) of the knee joint, for grading the KL stage and presenting the results of these three OA characteristics together. The new DL software MediAI-OA demonstrates good performance in analyzing knee OA characteristics, grading on the Kellgren-Lawrence (KL) scale, and diagnosing OA, comparable to that of experienced orthopedic surgeons and radiologists [8].

Therefore, reliable classification of the severity of knee OA can be achieved through the use of MediAI-OA and/or KOALA™, potentially reducing the radiologist's workload.

DISCUSSION

Imaging plays a crucial role in the diagnostic process, with methods such as radiography, magnetic resonance imaging (MRI), computed tomography (CT), and ultrasound being primary tools for visualizing knee osteoarthritis (OA). Additionally, vibro- and phonoarthrography serve as alternative diagnostic tools.

Among these, MRI is the most commonly used imaging modality. However, it has been noted to underestimate the extent of osteochondral lesions, potentially leading to insufficient and incomplete diagnoses. Artificial intelligence can strategically address these limitations in radiographic diagnosis of knee OA [5]. Reliable classification using the Kellgren-Lawrence (KL) OA classification system can be achieved through the use of MediAI-OA and/or KOALA™ [9]. While AI finds application across various medical domains, its broad clinical use remains limited until regulatory approval for specific investigational cases is obtained [9].

CONCLUSION

Diagnosing knee OA is typically conducted through clinical assessment of symptoms combined with radiographic findings indicative of OA, including joint space narrowing and osteophyte formation. Despite the widespread availability and cost-effectiveness of radiography, grading the severity of knee OA through this imaging modality alone may not suffice for detecting early OA changes and is subject to subjective variability in radiographic interpretation. Artificial intelligence has the potential to advance the field of radiology by enhancing efficiency, accuracy, and precision in the radiographic diagnosis of knee OA [9].

REFERENCES:

1. Varghese J. Artificial Intelligence in Medicine: Chances and Challenges for Wide Clinical Adoption. *Visc Med.* 2020 Dec;36(6):443-449. [PubMed]

2. Fiste O, Gkiozos I, Charpidou A, Syrigos NK. Artificial Intelligence-Based Treatment Decisions: A New Era for NSCLC. *Cancers (Basel).* 2024 Feb 19;16(4):831. [PubMed]

3. Korteling JEH, van de Boer-Visschedijk GC, Blankendaal RAM, Boonekamp RC, Eikelboom AR. Human- versus Artificial Intelligence. *Front Artif Intell.* 2021 Mar 25;4:622364. [PubMed]

4. Kann BH, Hosny A, Aerts HJWL. Artificial intelligence for clinical oncology. *Cancer Cell.* 2021 Jul 12; 39(7):916-927. [PubMed]

5. Neubauer M, Moser L, Neugebauer J, Raudner M, Wondrasch B, Führer M, et al. Artificial-Intelligence-Aided Radiographic Diagnostic of Knee Osteoarthritis Leads to a Higher Association of Clinical Findings with Diagnostic Ratings. *J Clin Med.* 2023 Jan 17;12(3):744. [PubMed]

6. Katz JN, Arant KR, Loeser RF. Diagnosis and Treatment of Hip and Knee Osteoarthritis: A Review. *JAMA.* 2021 Feb 9;325(6):568-578. [PubMed]

7. Smolle MA, Goetz C, Maurer D, Vielgut I, Novak M, Zier G, et al. Artificial intelligence-based computer-aided system for knee osteoarthritis assessment increases experienced orthopaedic surgeons' agreement rate and accuracy. *Knee Surg Sports Traumatol Arthrosc.* 2023 Mar;31(3): 1053-1062. [PubMed]

8. Yoon JS, Yon CJ, Lee D, Lee JJ, Kang CH, Kang SB, Lee NK, et al. Assessment of a novel deep learning-based software developed for automatic feature extraction and grading of radiographic knee osteoarthritis. *BMC Musculoskelet Disord.* 2023; 24:869. [Crossref]

9. Garwood ER, Tai R, Joshi G, Watts V GJ. The Use of Artificial Intelligence in the Evaluation of Knee Pathology. *Semin Musculoskelet Radiol.* 2020 Feb;24(1):21-29. [PubMed]

Please cite this article as: Subeva P, Gramatikova M. The role potential of artificial intelligence in knee osteoarthritis. *J of IMAB.* 2024 Oct-Dec;30(4):5786-5788. [Crossref - https://doi.org/10.5272/jimab.2024304.5786]

Received: 15/04/2024; Published online: 03/10/2024

Address for correspondence:
Petya Subeva - PhD Student
Department of Kinesitherapy, Faculty of Public Health, Health Care, and Sports, South-West University "Neofit Rilski" – Blagoevgrad;
66, Ivan Mihailov Str., 2700 Blagoevgrad, Bulgaria.
E-mail: petqsubevaa1995@abv.bg