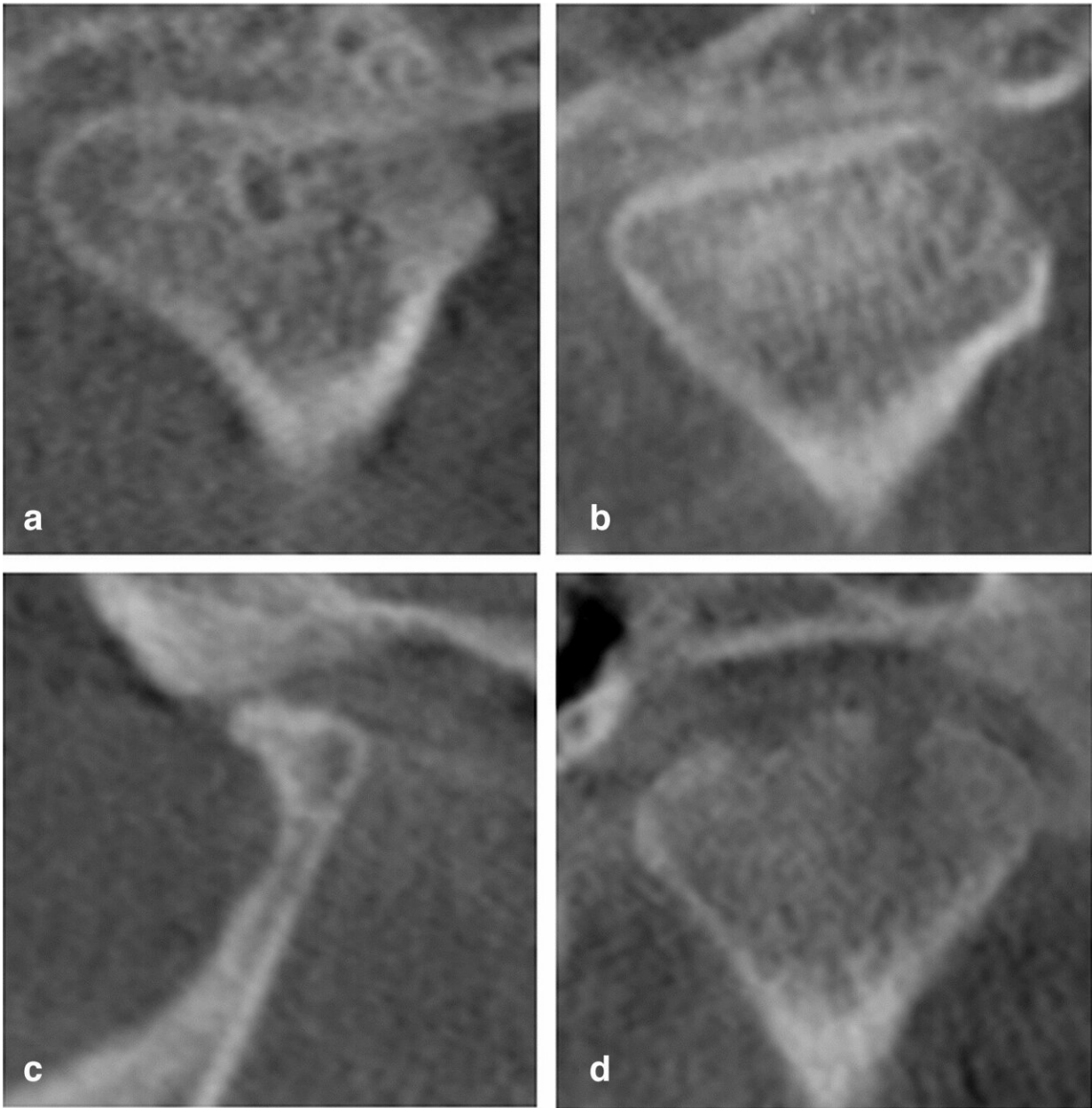


AI deep learning model diagnoses symptoms of joint diseases early and with high accuracy, say researchers

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The radiographic criteria used to confirm the diagnosis of osteoarthritis. (a) Subcortical cyst (radiolucent area that may be just below the cortex or in the trabecular bone). (b) Flattening of the articular surfaces (disappearance of the even convexity or concavity of the articular surfaces). (c) Osteophyte (bony outgrowth arising from a mineralized joint surface). (d) Surface erosion (condylar surface irregularities). Credit: *Scientific Reports* (2023). DOI: 10.1038/s41598-023-43277-6

Scientists say they have developed an artificial intelligence deep learning model with the ability to detect the early signs of degenerative joint diseases with a high degree of accuracy.

The scientists have [published](#) their new AI model in the journal *Scientific Reports* and claim the accuracy of their method surpasses that of an experience radiologist "when compared to a gold standard."

Although the study focuses on "[osteoarthritis](#) of the temporomandibular joint," the scientist maintain that their findings have direct and practical implications to diseases afflicting joints in general.

"The adoption of AI in the radiographic diagnosis of osteoarthritis is expected to eliminate the subjectivity associated with the human interpretation and expedite the diagnostic process thus reducing the probability of the disease progression," they write.

"The AI model used in the present study had equal or better diagnostic performance for TMJ osteoarthritis compared to the human expert."

Osteoarthritis, a degenerative joint disease, is the most common type of arthritis with high prevalence among older people. Patients with the disease suffer [joint pain](#). Rest or inactivity usually leads to temporary stiffness.

The authors note that current interpretations of the signs of joint diseases, particularly those afflicting the jaw, have been "highly subjective" as they have so far almost solely leaned on cone-beam computed tomography (CBCT) and become an obstacle on the path of an early and accurate diagnosis.

"The objectives of this study were to develop and test the performance of an [artificial intelligence](#) (AI) model for the diagnosis of TMJ

osteoarthritis from CBCT," they write.

TMJ, or temporomandibular joints, comprise the two joints connecting lower jaw to the skull, while CBCT is a three dimensional (3D) special type of X-ray imaging of teeth, nerve pathways, bone and soft tissues, which dentists resort to when regular X-ray screening is found insufficient for a proper diagnosis process.

To validate their AI model, the scientists' data and analysis involved a "total of 2,737 CBCT images from 943 patients. Two experienced evaluators performed a Diagnostic Criteria for Temporomandibular Disorders (DC/TMD)-based assessment to generate a separate model-testing set of 350 images in which the concluded diagnosis was considered the golden reference."

The scientist then compared the diagnostic performance of their AI model to those obtained by an experienced oral radiologist. They write: "The AI diagnosis showed statistically higher agreement with the golden reference compared to the radiologist.

"Cohen's kappa showed statistically significant differences in the agreement between the AI and the radiologist with the golden reference for the diagnosis of all signs collectively ($P = 0.0079$) and for subcortical cysts ($P = 0.0214$).

"AI is expected to eliminate the subjectivity associated with the human interpretation and expedite the diagnostic process of TMJ osteoarthritis."

The study, in which scholars from Egypt, the United Arab Emirates (UAE) and Lebanon took part, shows that the jaw joint disorder it examines is a sequel of other joint disorders that are not being adequately treated due to the shortcomings of current diagnostic methods.

As a result, patients with joint disorders "suffer from severe pain and headaches, joint sounds and functional disabilities that worsen with time and lead to permanent joint damage. The treatment of advanced forms of osteoarthritis requires extensive and expensive surgeries like total joint replacements," says the study's lead author Dr. Wael M. Talaat, Associate Professor of Oral and Maxillofacial Surgery at the University of Sharjah.

"Considering the high prevalence of these disorders, these treatments may burden the health authorities globally. Early diagnosis is a key factor in preventing the disease progression and achieving a successful treatment outcome. Early diagnosis is a key factor in preventing the disease progression and achieving a successful treatment outcome," Dr. Talaat points out.

Dr. Talaat says early diagnosis of temporomandibular disorders is often a challenge even to experienced practitioners. "This is due to the inconsistency in the [diagnostic criteria](#) and taxonomy between the different clinical and research centers and the referred pain that often mislead the examiner to other possible diagnosis.

"However, the most challenging factor that hinders the early diagnosis is the subjectivity of the interpretation of the signs of osteoarthritis. Studies have shown that hundreds of patients have consulted an average of 44 different medical specialty before reaching the diagnosis of their temporomandibular disorder."

Asked about the impact of their IA model, Dr. Talaat said, "The results of this project will improve the diagnostic process of osteoarthritis and eliminate the subjectivity associated with the human interpretation. This will allow the [early diagnosis](#) and stop the disease progression to advanced forms.

"The results of this study may pave the road for further clinical and research optimization of the model to allow the diagnosis of osteoarthritis at an early reversible phase. In general, AI aims to surpass the cognitive abilities of humans and improve the standards of care to ensure the patients' well-being."

The research team has developed a full cognitive AI model that interprets the data from the patients' history, [clinical examination](#) and the radiographic examination as well.

"The model is based on the most reliable and evidence-based diagnostic protocol (DC/TMD). The model utilizes several decision trees to conclude the diagnosis of temporomandibular disorders. The testing of the model will be conducted in an MSc thesis during the coming few months," adds Dr. Talaat.

Of whether the study had immediate practical implications, Dr. Talaat said, "The research is translational and is ready to be adopted in the clinical setting. The project used deep learning to automate an already validated, evidence based diagnostic protocol (DC/TMD). The full cognitive AI model is expected to significantly expedite and facilitate the complex diagnostic process of temporomandibular disorders.

"The timely identification of signs of TMJ osteoarthritis and the detection of patients at risk of progression to advanced forms may facilitate the development of more effective treatment approaches."

Dr. Talaat urged scientist to draw on and build up on the team's findings to expand "the current binary classifications to multinomial regression functions that recognize the clinical and radiographic findings in addition to the different biomarkers and classify the early, moderate and severe forms of TMJ osteoarthritis.

"The development of multinomial deep learning classifiers in the field of TMJ osteoarthritis can promote a line of research that investigates the possibility of diagnosis at an early reversible phase"

More information: Wael M. Talaat et al, An artificial intelligence model for the radiographic diagnosis of osteoarthritis of the temporomandibular joint, *Scientific Reports* (2023). [DOI: 10.1038/s41598-023-43277-6](https://doi.org/10.1038/s41598-023-43277-6)

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