

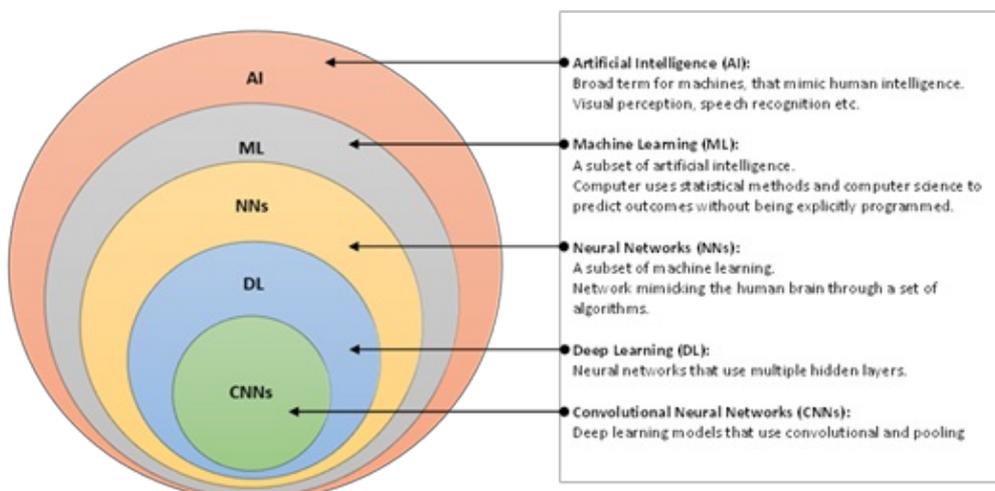
Sports Medicine: Artificial intelligence (AI) in Musculoskeletal Imaging



Artificial intelligence (AI) is penetrating all areas of our lives ever faster and deeper. Of course, this also applies particularly to medicine. Prof. Dr. In this article, Stefan Nehrer shows us how sports doctors can already benefit from new artificial intelligence methods in digital imaging. The new tools help to provide information as quickly as possible so that optimal therapy decisions and advice can be made.

The diagnosis and assessment of clinical pathologies is often tied to the collection of radiological imaging procedures, which initially include ultrasound, but also X-ray procedures. The assessment of the X-ray images is therefore often still the first step towards a differentiated diagnosis, which is then followed by MRI examinations as the gold standard. This preparation and processing of X-ray images often requires measurements of angles and length ratios, which firstly requires precise knowledge of the method, which is often time-consuming to implement and is associated with a certain degree of inaccuracy and low reproducibility. These measurements are usually not included in standard radiology reports. Sports physicians are therefore often required to take these measurements themselves - especially when measuring leg axis deviations on full-leg X-rays and assessing changes to the hip joint such as dysplasia or impingement. New AI processes in digital imaging provide support here and help to make the information available as quickly as possible in order to make optimal therapy decisions and advice

Digitalization has led to rapid developments in digital image processing and analysis in musculoskeletal imaging. The manual interpretation of X-ray images shows a high inter- and intra-individual variability due to the subjective evaluation and examiner-dependent factors, which in many cases leads to low accuracy and comparability. As in many areas, artificial intelligence (AI) also offers great potential for automatic evaluation and improvement of reproducibility in the area of digital X-ray procedures. The AI are computer programs (algorithms) that can extract and recognize characteristics and patterns of changes typical of diseases from the digital data material and subsequently learn to make diagnoses based on objective data analysis. "Deep learning" also uses neural networks that learn the characteristics of data material and analyze and amplify them in forward and backward loops. This should make the results more objective, more accurate and almost 100% reproducible. In addition, automated structural analyzes are possible on the digital data, which are not possible for the manual examiner with the naked eye. In order for neural networks to be able to recognize pathological changes on an X-ray image, all possible manifestations must be presented in large numbers in a learning phase. Therefore, all algorithms must be trained with training data containing different disease stages, patient morphologies and image qualities.



Overview of Artificial Intelligence

There are already several AI-based tools available for the automatic analysis of musculoskeletal disorders that can support radiologists and orthopedists. The automated evaluation is much faster than with manual analysis and the results are presented in clear reports that can also be used for documentation and patient education. The results must always be confirmed by the treating doctor. To illustrate the areas of sports medicine and joint surgery, two software solutions for the automatic detection of typical pathologies are shown as examples.

The **IB Lab HIPPO** module is intended for adults between 18 and 95 years of age with hip pain, suspected congenital diseases such as hip dysplasia, femoral-acetabular impingement or hip osteoarthritis and enables the automated measurement of pelvic and hip morphology. The relevant angles and measuring distances are analyzed on an app x-ray image of the pelvis. HIPPO was developed using deep learning algorithms trained on over 4,000 individual pelvic and hip x-rays. The AI follows the established radiological workflow, whereby anatomical landmarks are recognized, measurements of anatomical distances and angles are carried out, disease morphologies are recognized and standardized classification and reporting is carried out. Using the radiological parameters (e.g. CCD and LCE angles, Tönnis angle (Acetabular Index), Sharp angle and Femoral Extrusion Index), pathologies such as hip dysplasia or FAI can be automatically identified and patients can be given the appropriate therapy quickly.



HIPPO evaluation with automatic measurement of the relevant radiological parameters (from Stotter et al. 2023)

The **IB Lab LAMA** module is available for AI analysis of whole leg X-rays, which fully automatically measures the leg axis and can thus identify valgus and varus deviations. The bone and leg length is also measured, as well as a detailed determination of the relevant joint angles to localize the deformity. For example, by determining the mechanical lateral distal femoral angle (mLDFW) and the mechanical medial proximal tibial angle (mMPTW), it can be determined whether a varus deformity is femoral or tibial in origin. This enables, on the one hand, rapid identification of relevant leg axis deviations and, on the other hand, precise measurement of the deviation. This information is essential for the treatment of patients with internal knee injuries and knee osteoarthritis, especially if there is a relevant leg axis deviation that can be addressed by a corrective osteotomy.

The digital procedures can be easily integrated into the local software of the practice or into a PACS system and thus support the process but also the documentation of the diagnosis and treatment decisions, which ultimately leads to more time in direct patient care.



Disclosure:

Imaging Biopsy Lab is a cooperation partner in several research projects and product development programs of the Center for Regenerative Medicine at the University of Krems.

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