Chapter 6
Artificial Intelligence in Orthopedic Implant Model Classification

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ABSTRACT

Although past studies and the performance of prior models have not been assessed, artificial intelligence models have shown great accuracy in distinguishing particular orthopedic implant types from imaging, which is an essential and time-consuming operation. To describe the breadth, approach, and effectiveness of artificial intelligence algorithms in categorizing orthopedic implant models, the authors carried out a comprehensive review. They used the search phrases "artificial intelligence," "orthopedic," "implant," and "arthroplasty" to look at research published up to March 10, 2021 in PubMed, EMBASE, and the Cochrane Library. A modified version of the methodologic index for non-randomized studies was used to evaluate the studies. Area under the receiver operating characteristic curve (AUC), accuracy, sensitivity, and specificity were among the results that were reported. Eleven of the 2689 records found during the search were used in the analysis. Between 2 and 27 implant models were considered.

DOI: 10.4018/978-1-6684-7412-9.ch006

INTRODUCTION

Musculoskeletal radiologists and orthopaedic surgeons often undertake radiographic examination of arthroplasty and other orthopaedic implants for postoperative surveillance and surgical planning. With over 250,000 total hip and total knee revisions projected annually by 2030 (Han & Tian, 2019), revision arthroplasty is a procedure that is becoming more and more common. The preparation for this procedure depends on identifying the specific implants used so that implant-specific tool kits are available at the time of surgery (Olczak et al., 2017). Sadly, since this information is frequently missing, locating the implant may require time-consuming efforts and error-prone methods, such as using orthopaedic implant atlases of postoperative radiographs (Kurmis & Ianunzio, 2022). According to an American Association of Hip and Knee Surgeons study conducted in 2012, the average time it takes for a surgeon and staff to select an implant before surgery is 20 and 30 minutes, respectively (Myers et al., 2020). Additionally, this study discovered that failure to identify components may result in the need for more implants, longer operating room sessions, more complicated procedures, and higher levels of blood loss, bone loss, recovery time, and expense (Ko et al., 2022). Over 50,000 implants are expected to go unidentified each year prior to surgery, which could have further negative effects on costs and patient outcomes (Helm et al., 2020). The cost of identifying implants in hip and knee arthroplasty in the USA alone has been projected to reach up to 3.3 million cumulative US dollars by 2030.

Artificial Intelligence (AI), the capacity for machines to process information similarly to humans, has advanced significantly in recent years (Ren & Yi, 2022). Machine learning has recently shown the capacity to carry out diagnostic tasks for medical imaging in a manner comparable to that of radiology experts, particularly when using deep learning and Deep Convolutional Neural Networks (DCNN), which are cutting-edge algorithms made up of multiple algorithmic layers (Maffulli et al., 2020). In musculoskeletal radiography, deep learning algorithms have shown expert-level proficiency in a range of radiographic tasks, including the precise identification of certain orthopaedic implant types. With accuracy comparable to or even surpassing that of expert human readers and at much faster speeds, deep learning models have been described in several studies as identifying implant types for arthroplasty of the hip (Bian et al., 2020), knee (Federer & Jones, 2021), and shoulder (Seibold et al., 2021). This could lessen the burden on doctors to identify orthopaedic implants from radiographs. These results are intriguing, but no comprehensive analysis has yet looked at the range and effectiveness of AI algorithms in classifying orthopaedic implants (Oosterhoff & Doornberg, 2020). In musculoskeletal radiography, deep learning algorithms have shown expert-level proficiency in a range of radiographic tasks, including the precise identification of certain orthopaedic implant types (Poduval et al., 2020). With accuracy comparable to or even surpassing that of expert human readers and at much faster speeds, deep learning models have been described in several studies as identifying implant types for arthroplasty of the hip, knee, and shoulder (Zhang et al., 2022). This could lessen the burden on doctors to identify orthopaedic implants from radiographs. These results are intriguing, but no comprehensive analysis has yet looked at the range and effectiveness of AI algorithms in classifying orthopaedic implants (Chen et al., 2022).

LITERATURE SEARCH AND SCREENING TECHNIQUES

We conducted a thorough search of the PubMed, According to PRISMA 2020 standards, all studies published up to February 9, 2021, should be included in EMBASE and the Cochrane Central Register