Assessing the Current Layout of Artificial Intelligence Applications in Chronic Elbow Pain Disorders: Scoping Review Protocol

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Abstract

Review Question: What AI technologies are available for pain medicine physicians treating adult patients with chronic elbow pain?

Introduction:
Chronic elbow pain, which includes conditions such as tendinopathies, bursitis, nerve compression syndromes, and osteoarthritis, presents a significant diagnostic challenge due to the complexity of the joint and its surrounding structures. Artificial intelligence (AI) holds great potential in improving the efficiency of diagnosis, prognosis, and treatment in musculoskeletal disorders. However, there is no comprehensive review of the AI applications specifically targeting chronic elbow pain. This scoping review seeks to address this gap by analyzing existing AI technologies relevant to pain medicine.

Inclusion Criteria:
This review will include peer-reviewed studies involving adult patients with chronic elbow pain, where AI technologies are applied to predict, diagnose, manage, or classify these disorders. Studies on AI applications in musculoskeletal and pain medicine that focus on the elbow will be included.

Methods:
A comprehensive search will be conducted in MEDLINE and Embase databases. Covidence software will be used to manage the selection process, remove duplicates, and facilitate data extraction. The review will follow the PRISMA-ScR guidelines. Findings will be synthesized through a narrative analysis, highlighting the current state of AI applications in chronic elbow pain and identifying research gaps for future investigation.

This review will provide a valuable foundation for understanding AI's role in pain medicine and its potential impact on the management of chronic elbow pain.

Authors' Contributions

JUP conceptualized the research question, with support from MB and MJ. JUP conceptualized the search. JUP created the search terms and MB and MJ will perform the database searches. The review will be double-blinded with a third reviewer in case of conflict. JUP will be the primary author of the article. GD is the preceptor and topic expert for the peer-reviewed article.

Registration

This protocol will be archived in PRISM: University of Calgary Digital Repository (https://prism.ucalgary.ca). The protocol will be reported using the recommended PRISMA-ScR (PRISMA extension for Scoping Reviews) (Tricco *et al*., 2018).

Ethics and Dissemination

Ethics approval is not required. No additional collaborators or stakeholders are involved in this project beyond the authors listed in this paper. This project will be disseminated to an appropriately selected journal upon completion.

Support/Funding

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Conflict of Interest

We have no conflicts of interest to declare, as outlined by the ICMJE recommendations.

Key Words

Artificial Intelligence, Chronic Pain, Elbow, Medicine

Introduction

Artificial Intelligence (AI) is transforming healthcare by enhancing efficiency, reducing costs, and improving decision-making across various fields, including sports medicine and pain medicine (Kueper *et al.*, 2020; Khan *et al.*, 2024). In particular, AI technologies hold significant potential in managing musculoskeletal disorders (Ramkumar *et al.*, 2022; Fayed et la., 2023; Pareek *et al.*, 2024). Among these disorders, chronic elbow pain, encompassing conditions like elbow tendinopathy, epicondylitis, olecranon bursitis, and nerve entrapment syndromes, represents a critical area where AI can contribute to better diagnosis and treatment.

Chronic elbow pain presents a diagnostic and therapeutic challenge due to the complexity of the joint and its surrounding structures. The elbow is composed of three articulations: the ulnotrochlear joint (a hinge joint), the proximal radioulnar joint (enabling rotation), and the radiocapitellar joint (allowing both hinge and rotational movements). These articulations, along with surrounding ligaments and tendons, enable a wide range of motions, including elbow flexion and extension, as well as forearm pronation and supination. Furthermore, the distal humerus serves as the attachment site for multiple muscle-tendon units, facilitating wrist and finger movements. The intricate anatomy is compounded by the presence of key nerves—radial, median, and ulnar—which can be involved in various pathologies (Daniels & Fritz, 2023).

Patients with chronic elbow pain may present with a variety of symptoms, such as swelling, pain, stiffness, restricted range of motion, and numbness or tingling, contributing to a broad differential diagnosis that can include osseous, soft tissue, cartilaginous, or nerve-related conditions (Thomas *et al.*, 2022). While radiographs are typically the first imaging modality, further assessment often requires ultrasonography (US) or Magnetic Resonance Imaging (MRI). Electromyography (EMG) may be used to evaluate nerve involvement, while conservative treatments, including physical therapy, corticosteroid injections, and activity modification, are often first-line approaches. In more severe or persistent cases, surgical intervention may be necessary, especially in cases involving ligament injuries, biceps tendon damage, or nerve entrapment syndromes (Javed *et al.*, 2015).

Pain medicine physicians specialize in diagnosing, treating and managing pain and a range of painful disorders, including chronic elbow pain (Belgrade, 2020; Feinberg, 1996). Given the diagnostic complexity and the varied treatment pathways, an AI tool that aids in the evaluation and management of chronic elbow pain could offer significant advantages to pain medicine physicians by streamlining processes and enhancing decision-making. With the increasing prevalence and efficacy of AI in medicine, it is essential to understand the current research landscape on AI applications, particularly AI in chronic elbow pain. There have been studies conducted to review AI applications in some aspects of musculoskeletal and pain medicine, including shoulder, hip, knee and low back pain (Cheng *et al*., 2024; Lopez *et al*., 2021; D'Antoni *et al*., 2022). However, there has not yet been a comprehensive review of the recent advancements in chronic elbow pain. The differential diagnosis for chronic elbow pain is broad, necessitating accurate diagnosis for appropriate rehabilitation and treatment.

A comprehensive overview of existing AI technologies and their applications in this context has potential for informing clinical practice and guiding future research. Therefore, this review's purpose is to conduct a scoping review to map and analyze the existing literature on AI technologies related to chronic elbow pain. By identifying emerging technologies, methodologies, and research gaps, this review will be a basis to provide insights that can inform future research directions and innovation strategies in pain medicine.

Review Question: What AI technologies are available for pain medicine physicians treating adult patients with chronic elbow pain?

Methods

This review will follow the PRISMA-ScR reporting guidelines for scoping reviews (Tricco *et al*., 2018). The review team will consist of four members including, a pain medicine physician (GD), and three medical students (JUP, MB, MJ).

Eligibility Criteria

The eligibility criteria will be based on the PCC framework, as per **Table 1**.

Table 1: PCC Framework for Scoping Review.

Element	Definition
P - Population	Adults (>18 years) with chronic elbow pain disorders, including tendinopathies, bursitis, nerve compression syndromes, and osteoarthritis.
C - Concept	AI technologies focused on predicting, prognosticating, diagnosing, managing, or classifying

	chronic elbow pain, including machine learning, deep learning, computer vision, generative AI, and ChatGPT.
C - Context	All settings where AI technologies may be used by or are relevant to pain medicine physicians.

The aim of the search is to find articles that investigated the use of AI in the diagnosis, management, or treatment of elbow pain in pain medicine. The inclusion and exclusion criteria were modeled off a previous ML in Pain Medicine Systematic Review (Matsangidou *et al*., 2021).

Inclusion criteria focus on studies involving human subjects over 18 years with chronic elbow pain, where the AI technologies are or can be applied in clinical practice. Exclusion criteria exclude studies on pediatric or acute pain cases, non-original research, and studies focused on technical aspects of AI without direct application to pain medicine. Pediatric cases and acute cases were not included due to the research focus on chronic pain and the broad scope of the research. Full criteria are listed in **Table 2**.

Table 2: Inclusion and exclusion criteria.

Inclusion Criteria	**Exclusion Criteria**
Adults with chronic elbow pain	Publications conducted in the pediatric population (under 18 years of age)
Any gender	Publications where the technology application was not primarily focused on predicting, prognosticating, diagnosing, managing, or classifying chronic elbow pain (i.e. database development, technical papers focused on AI technology rather than pain)
Human subjects or human applications were involved	Publications focused on general widespread chronic pain conditions which involve the forearm, or referred pain conditions (e.g. cervical radiculopathy, or rotator cuff tendinopathy).
Full article was in English	Publications that were not original studies (i.e. review articles, letter to the editor, conference papers, letters to the editor)
Publication studied the use of artificial intelligence or machine learning or deep learning as an application for chronic elbow pain	Publications whose abstracts or full text were not available or could not be obtained
Technology application was relevant to conditions seen by pain medicine physicians	Duplicate publications

Information Sources and Search Strategy

The search strategy was developed by the research team with a librarian's help. Trial searches were conducted in MEDLINE and Embase on September 1, 2024, using relevant terms related to elbow pain and AI technologies. The citation management for this study will be handled using Zotero. The complete search strategy for MEDLINE is outlined in **Table 3**.

Table 3: MEDLINE Search Strategy conducted on Sept 1, 2024.

#	Searches	Results
1	exp Elbow joint/	13352
2	exp Elbow injuries/	7987
3	(elbow adj2 (injur* or inflam* or pain* or fractur* or joint or syndrome* or procedur* or surg* or patholog* or disorder* or tendinopath* or arthroplast* or tennis or golfer* or "little league" or baseball or "medial condyle" or "lateral epicondyle" or olecranon or humerus or radius or ulna* or "nerve compress*" or imping* or synovitis or plica or "osteochondritis dissecans" or osteoarthritis or bursitis)).tw,kf.	14524
4	exp Arthroplasty, Replacement, Elbow/	510
5	exp Collateral Ligament, Ulnar/	369
6	((radial or ulnar or annular) adj2 ligament*).tw,kf.	2435
7	1 or 2 or 3 or 4 or 5 or 6	27510
8	exp Artificial Intelligence/	206765
9	artificial intelligen*.tw,kf.	57420
10	AI.tw,kf.	60564
11	machine learning.tw,kf.	122960
12	exp Deep Learning/	22141
13	deep learning.tw,kf.	69987
14	large language model.tw,kf.	1027
15	GenAI.tw,kf.	37
16	ChatGPT.tw,kf.	4090
17	8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16	358977
18	7 and 17	202

Study Selection/Screening

The study selection process will involve two independent stages. The first stage of the selection process will consist of titles and abstract screening. Two independent reviewers will carry out this task using Covidence. The studies that meet inclusion criteria will pass to the next phase. A pilot process will be conducted for the full-text screening phase. In this stage, the two independent reviewers will randomly select 10% of the citations to determine their eligibility for inclusion. If consistency is observed between the reviewers' decisions in this pilot phase, they will proceed to screen the remaining full texts (Higgins *et al.*, 2022). For all stages, conflict will be resolved among the two reviewers and a third if necessary.

Data Extraction:

Data extraction will be conducted by two reviewers using Covidence. Key variables to be extracted include study title, year of publication, type of elbow pain, AI technology, study design, data source, AI application, and key findings. **Table 4** describes data fields that will be extracted.

Table 4: Data fields to be extracted from full-length papers.

Variable	**Input Description (examples)**
Study Title	Text
Year of Publication	Text
Type of Elbow Pain	Tendinopathy, bursitis, nerve compression syndrome, and osteoarthritis.
Technology	Type of Artificial Intelligence including AI, Machine Learning, Deep learning, Large Language Model, ChatGPT, Generative AI
Methods	Study design
Data Source	Data used to train the AI can include self-reported data, medical record data, imaging, biomarkers, accelerometer
Use of AI	Intended use of AI can include predicting, prognosticating, diagnosing, managing, or classifying chronic elbow pain
Key findings - statement from abstract or conclusion	Text, outcomes, statistical outcome assessed

Synthesis and Presentation of Results

The results will be synthesized through a narrative analysis organized by AI technology, its application, and data sources. The review will include a PRISMA flow diagram and be presented in tables, figures, and diagrams to illustrate the findings. Additionally, noteworthy articles will be identified and highlighted.

Conclusion

Chronic elbow pain is inherently complex due to the intricate anatomy of the elbow joint and its surrounding structures. The elbow comprises three articulations, several ligaments, and key nerves, allowing for a wide range of movements but also making it susceptible to a variety of pathologies. Patients may experience a spectrum of symptoms, and diagnosis often involves multiple investigations including imaging modalities and electrophysiological tests. Treatment options range from conservative management to surgical intervention, depending on the underlying condition. AI tools that assist with the diagnostic and management process could greatly benefit physicians by optimizing decision-making and improving patient outcomes. This scoping review will help map and summarize the evidence concerning which AI technologies, being developed for chronic elbow pain, may be applicable for pain medicine physicians to use in their practice.

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