The Need for Standardized Pain Measurements in Orthopaedic Biomechanics Research: A Systematic Review of the Hand Osteoarthritis Literature

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INTRODUCTION: Musculoskeletal research is multidisciplinary. Among those interested, biomechanists and pain scientists have key roles. Biomechanists often aim to understand movement adaptations, thereby indirectly assessing to what extent pain (and other symptoms) modulate movement. In contrast, pain scientists quantify the experience of pain on the affected joint and identify the loss of nociception and increased sensitization throughout the body, but rarely correlate quantified pain with changes in movement. To evaluate the importance of incorporating the study of pain into biomechanics studies, we reviewed the literature across the pain and biomechanics fields. We specifically focused on hand osteoarthritis (OA), as OA is a multifactorial joint disease widely studied across the pain and biomechanics fields. Additionally, the limited literature on hand OA presented a feasible scope for capturing all relevant articles. This literature review aims to provide background on quantitative pain methods, describe the need for standardization within and across the pain and biomechanics fields, and provide suggestions for using pain research methods to elucidate the complex mechanisms behind diseases, such as hand OA.

METHODS: A systematic literature review was conducted to identify literature studying hand OA from the biomechanics and/or pain perspectives. We implemented a search strategy with the search entries "osteoarthritis", joint type (e.g., carpometacarpal), and methods (e.g., motion capture) in PubMed and Web of Science. We initially identified 168 articles in the biomechanics field and 86 in the pain field published up to June 2022. After excluding duplicate studies, two reviewers independently screened the titles and abstracts of the identified articles. Inclusion criteria for both bodies of literature were: (i) studies written in English and published in a peer-reviewed journal and (ii) human participants with any type of hand OA. Additional inclusion criteria for biomechanics literature were studies that measured muscle activity, kinematics, or a kinetic parameter other than clinical metrics of strength (i.e., grip or pinch strength). Inclusion criteria for pain literature were studies that utilized some form of quantitative pain measurement, mainly quantitative sensory testing (QST). Data extracted included (1) patient demographics; (2) joint affected by OA; (3) OA diagnostic method; (4) grip strength, (5) pinch strength (e.g., tripod pinch, lateral pinch, and tip pinch); (6) visual analog scale (VAS) scores; (7) numeric rating scale (NRS) scores; (8) clinical outcome assessment used. A one-way analysis of variance (ANOVA) was used for all comparisons. Post-hoc testing was performed with Tukey correction, with an obtained $\alpha = 0.005$.

RESULTS: Forty-six studies met the inclusion criteria (20 biomechanics and 26 pain studies). The studies highlighted that cross-collaboration between the biomechanics and pain fields is largely absent, with only diagnostic methods and clinical outcome measurements linking them (Fig. 1). Both biomechanics and pain studies commonly established a diagnosis of hand OA using radiographs and/or clinical judgment. These studies were further broken down into hand, thumb, or interphalangeal OA. Thumb OA was the most studied in both fields with 55% and 54% of the biomechanics and pain studies, respectively, classified as thumb OA. Clinical outcome assessments were measured more often in the pain studies than biomechanics studies; yet, over 8 different assessments were identified across all studies (Fig. 2). The largest overlap in outcome measures between fields was the VAS pain scores. However, this overlap included only 9 (20%) total articles. In terms of functional assessments, the most common outcome score in the biomechanics studies was the PRWE (n = 5, 25%), whereas the pain studies most commonly reported the quickDASH (n = 4, 15%). Demographics, strength measurements, and discussion of pain also differed between fields. Participants in the biomechanics studies were younger than those in pain studies. Pinch and grip strength measurements were higher in participants in the biomechanics studies than those in the pain studies. Most importantly, when closely examining only the biomechanics studies, the majority (n = 11, 55%) did not acknowledge pain in the discussion section, even though it was measured in 9 (45%) of the studies.

DISCUSSION: Through detailed data extraction and analysis of a concise group of papers related to hand OA, we highlighted that further research on the relationship between pain and movement is needed. To date, biomechanists have studied how OA changes kinematics, kinetics, and muscle activity in the hand. This work has been useful in identifying predictors of the disease but rarely looks beyond the localized area of joint damage. In contrast, pain researchers provide evidence that pain due to hand OA may have central mechanisms, meaning that elements of increased sensitization are present in parts of the body beyond the affected joint. While the research methods used by biomechanists and pain scientists differ, they share an underlying interest in understanding disease progression, functional limitation, and pain prevention (Fig. 3). Advancing our understanding of the complex and dynamic relationship between pain and movement will require shared methodology and greater consensus between pain and biomechanics fields. It should be noted that this review was limited in scope in order to cover all available literature related to a single disease domain (i.e., hand OA) in the pain and biomechanics fields. As a result, different methodological approaches used to study other forms of OA and musculoskeletal diseases may be absent. Nonetheless, our findings imply that measuring pain in biomechanics studies using quantitative methods followed by analytical discussion will close the gap between fields and advance our understanding of the relationship, both negative and positive, between movement and pain.

SIGNIFICANCE/CLINICAL RELEVANCE: There is clear importance in studying pain and movement together to fully understand the role of pain in disease progression and movement adaptation. Enhanced understanding of pain and movement, the primary impairments of OA, could inform future treatments.

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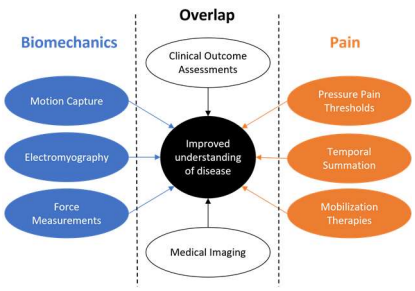

Figure 1. Methods used by biomechanists and pain scientists to understand disease.

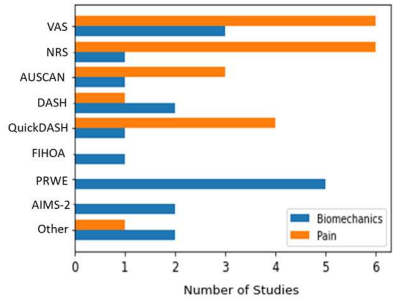

Figure 2. Clinical outcome assessments used in the identified biomechanics and pain studies.

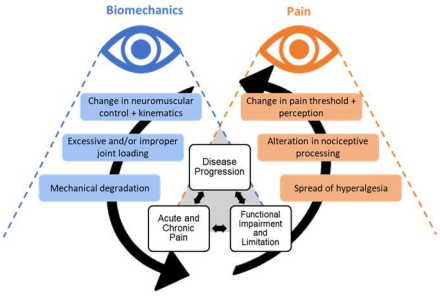

Figure 3. The perspective and intersection of biomechanics and pain.