

# Disruption Index Analysis of Shoulder Surgery Literature: Characterizing Patterns in Orthopedic Innovation

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**INTRODUCTION:** Shoulder surgery literature has demonstrated significant advances over the past six decades, but a quantitative understanding of which publications truly disrupt the field versus those that consolidate existing knowledge remains limited. The Disruption Index (DI), a validated bibliometric value, provides a novel approach to assessing whether subsequent research shifts attention away from a publication's references (disruptive innovation) or builds upon them (consolidation). This study applies this cutting-edge framework to identify the most transformative findings in shoulder surgery literature and uncover patterns that traditional citation metrics may overlook.

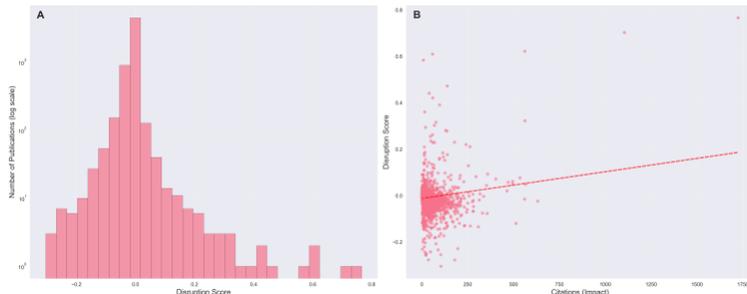
**METHODS:** 5,878 shoulder surgery publications were analyzed from PubMed (1954-2014) using Wu et al.'s validated disruption framework. The analytic window was restricted to 1954–2014 to ensure each publication had at least ten years for citation accrual, thereby minimizing temporal bias in disruption index calculations, and because the validated disruption dataset is available only through 2014. Disruption scores were calculated as  $D = (N_f - N_b) / (N_f + N_b + N_r)$  where  $N_f$  = papers citing focal but not references,  $N_b$  = papers citing both,  $N_r$  = papers citing only references. The top 100 most disruptive and top 100 most cited publications were identified while also recording team size, study design, clinical topics, and temporal trends. Statistical analyses included correlation testing and descriptive statistics.

**RESULTS:** This analysis revealed a striking concentration of disruption scores, with approximately 4,450 publications clustering at neutral values ( $D \approx 0.0$ ), indicating strong consolidation tendencies. Team size analysis uncovered optimal innovation at 5 authors (1,177 papers), followed by 4 authors (1,112 papers) and 3 authors (1,061 papers). Average disruption scores were consistently negative across team sizes (-0.003 to -0.020), indicating overall consolidation bias. Most notably, citation-disruption correlation was remarkably weak ( $r = 0.148$ ), revealing that traditional impact metrics fail to capture true innovation. The most disruptive paper achieved  $D = 0.766$  with 1,724 citations, while the most cited paper (same study) demonstrated that high disruption and high citation may coexist.

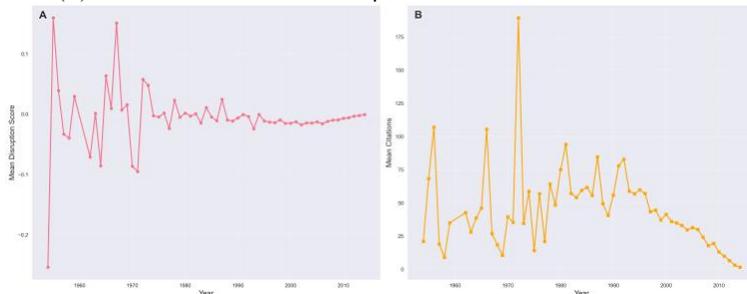
**DISCUSSION:** Our findings challenge conventional wisdom regarding academic innovation in shoulder surgery. Shoulder surgery's strong consolidation bias (average  $D = -0.009$ ) suggests most research builds incrementally rather than disruptively. The weak citation-disruption correlation fundamentally questions our reliance on citation-based metrics for identifying innovative research. The optimal team size of 5 authors suggests moderate collaboration maximizes disruption potential, while the coexistence of high disruption and high citations in top papers indicates these metrics can align in exceptional cases. The scope of the findings is limited to innovation dynamics through 2014, given that the disruption index is validated only until that year.

**SIGNIFICANCE:** This study provides the first disruption analysis in orthopedic surgery, offering unprecedented insights into innovation patterns that can guide research funding, collaboration strategies, and evidence-based approaches to advancing shoulder surgery knowledge. Understanding these dynamics is crucial for identifying and supporting truly transformative research.

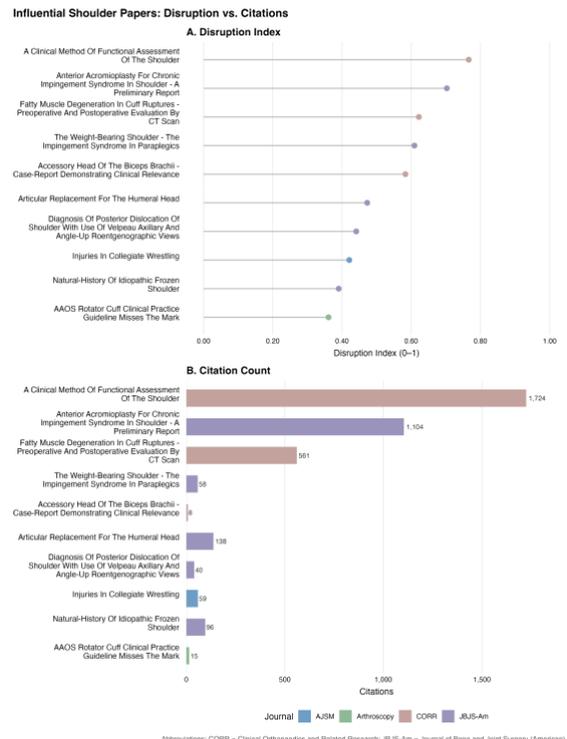
**REFERENCES:** Wu L, Wang D, Evans JA. Large teams develop and small teams disrupt science and technology. *Nature*. 2019;566(7744):378-382.



**Figure 1:** (A) Distribution of disruption scores across shoulder publications from 1954-2024. (B) Correlation of citations and disruptions.



**Figure 2:** (A) Mean disruption index per publication by year of from 1954 to 2024. (B) Mean number of citations per publication from 1954 to 2024.



**Figure 3:** (A) Top 10 papers in shoulder surgery literature by disruption index and (B) corresponding citation count.