

Communication

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Communication

“Native” Joint Versus “Step” Joint: There Is More Way from Data Collection to Comprehensive Conclusion

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Abstract

The human body consists of multiple joints with many degrees of freedom that open the context for biomechanical interventions in the form of recommendations and feedback, with the purpose of improving performance, reducing the risk of injuries, and so forth. These interventions sometimes involve loading trade-offs between joints or loading redistribution. Removing the load from one joint or segment (“native” joint) and transferring it to another joint (“step” joint) seem to need more consideration. Therefore, the aim of the current paper is to highlight the necessity of scientific communication from data collection to conclusions in the form of recommendations, presentations, and publications. The tendency to focus on specific joints and develop expertise hides the trade-off between joint loads, and sometimes, recommendations or feedback on the basis of biomechanical loading simply shift the risk of injury. To address this concern, several approaches are suggested, including improved marker sets, dataset availability, departmental diversity, research team collaboration, and the sharing of conferences and sessions.

Keywords: biomechanics; joint; digital shearing; research team; diversity

Introduction

The human body consists of multiple joints, and the health and proper function of these joints are required for smooth and optimal movement, which distinguishes humans from some human-made robots. These characteristics of the human body provide an opportunity for the investigation of many fields of study, such as biomechanics, and for the development of many departments worldwide that aim to improve health and quality of life. The complexity of movement has led to the growth of specialized and focused research teams, whether as part of a department or as independent departments. Additionally, opportunities for collaboration, communication, and diversity among them can be observed through collaborative projects (<https://spexor.eu/publications/>), conference participation, and publications; hence, there is a question: is it working perfectly?

Research has shown that any changes in the normal function of any joint may be reflected in the biomechanical function of other joints under the supervision of the neural control system (Panjabi, 1992). In the most seemingly simple case, the control system tries to maintain the lowest energy expenditure while standing by reducing muscle activity, specifically in the spine, as a subsystem of stability through compensatory spinal curve adjustments to provide standing balance with as little physiological cost as possible (Schwab et al., 2010).

The action of the control system is more complicated in dynamic situations than in standing and requires more sophisticated control and integrity of the subsystems, which could occur during athletic performance, which requires developed motor control (Mercier et al., 2020). Nevertheless, continuous exposure of human joints to overloading and repetitive loading reduces the chance of the control system providing enough safety margin to reduce the risk of injury in these conditions. Therefore, this opens the context for biomechanical interventions in the form of recommendations

(Waters et al., 1993), feedback and developing exoskeletons (Baltrusch et al., 2020; Gull et al., 2020), with the purpose of improving performance (Ericksen et al., 2013), reducing the risk of injuries (Oppici et al., 2021; Punt et al., 2020), and so forth.

These interventions sometimes involve loading trade-offs between joints or loading redistribution. For example, the lumbar spine and knee are joints at high risk of causing disability, as low back pain and osteoarthritis are among the 14 leading causes of disability among all diseases, and they are the first and second most common musculoskeletal diseases, respectively, leading to years lived with disability (Diseases & Injuries, 2024). There are paradoxical recommendations for managing manual handling of biomechanical loads, which makes it difficult to reach conclusions about safety in the workplace. For lifting and lowering, although there is controversy in the literature about safe styles (von Arx et al., 2021), there is a recommendation to pick up the load by bending the knees (Boocock et al., 2024; Prisco et al., 2024), e.g., the squat technique, whereas squatting has been identified as an occupational risk factor for knee osteoarthritis (Yucesoy et al., 2015), and only a few studies consider this trade-off (Gallagher et al., 2011). Indeed, removing the load from one joint or segment ("native" joint) and transferring it to another joint ("step" joint) seem to need more consideration. Therefore, the purpose of the current paper is to highlight the necessity of scientific communication from data collection to conclusions in the form of recommendations, presentations, and publications.

Discussion

In the new era of digital and information growth and the need for a deep understanding of human movement biomechanics, there is a tendency to focus on specific joints and develop expertise. Despite the benefits of this expertise, a lack of communication among researchers working on the different joint sometimes leads to joint-loading trade-offs that have not been deeply considered and makes it difficult to predict the loading of other joints as secondary joints. Additionally, this prespective gives researchers the confidence to ignore some important parts of the research protocol for comprehensive evaluation of movement biomechanics by focusing on a single joint or body part. This results in researchers effectively examining only part of the body when organizing research teams, departments, or even laboratories (e.g., lower extremities, upper extremities, and spine). This limitation becomes more critical in highly dynamic movements, such as those studied in sport biomechanics.

There are other possible reasons for the single-joint perspective, such as lack of expertise, limited resources, time savings, and attracting participants to experimental studies by reducing preparation protocols for attaching markers and electrodes to the body. Although standard marker sets are available from commercial biomechanics companies, they are usually not sufficient for detailed analysis of certain body parts, such as the spine, which has a multisegmented structure (Ignasiak et al., 2017; Nematimoez et al., 2025; Schmid et al., 2022; Seerden et al., 2019; Zwambag et al., 2019). A full and extended marker set could also help support the development of algorithms for predicting segmental motion, which would be required for markerless technologies (Colyer et al., 2018) that may, in the future, address marker set challenges (Nogueira et al., 2025).

"Step" joint perspective comes at the cost of losing information from other joints that may have valuable data. It seems necessary to emphasize that while expertise and focused research have invaluable benefits, the lack of communication and collaboration leads to the loss of resources, time, and, most importantly, valuable information that other teams and laboratories may not have the ability to measure. Such as human movement without abnormal joints, it seems that diverse research teams within a department or developed collaborations among diverse teams lead to smoother research progress, and higher productivity.

Future Directions

There are several possible solutions to this challenge that could be invaluable: first, fully detailed marker sets for measurements can be used, especially in the case of dynamic experiments, and freely available datasets can be provided. Second, partnering with research teams or groups that are related to our “step” joints. Third, providing dedicated conferences and sessions for communication to address biomechanical challenges related to recommendations, feedback options, and developing exoskeleton for managing high-risk loading conditions.

Conclusions

The tendency to focus on specific joints and develop expertise hides the trade-off between joint loads, and sometimes, recommendations, feedback, or developing exoskeleton just shift the risk of injury to “step” joints. To address this concern, several approaches are suggested, including improved marker sets, dataset availability, departmental diversity, research team collaboration, and the sharing of conferences and sessions.

Data Availability Statement: Data sharing is not applicable to this article as no datasets were generated or analysed during the current study.

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