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Shoulder proprioception: How is it measured and is it reliable? A systematic review

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ABSTRACT

Study Design: Systematic review.
Introduction: Constituents of proprioception include our awareness of the position (joint position sense [JPS]) and motion (kinesthesia) of our limbs in space. Proprioceptive deficits are associated with musculoskeletal disorders but remain a challenge to quantify, particularly at the shoulder.
Purpose of the Study: To report the psychometric values of validity, reliability, and responsiveness for shoulder JPS and/or kinesthesia protocols.
Methods: A review of 5 databases was conducted from inception to July 2016 for studies reporting a psychometric property of a shoulder proprioception protocol. The included studies were evaluated using the QualSyst checklist and COSMIN 4-point scale.
Results: Twenty-one studies were included, yielding 407 participants and 553 evaluated shoulders (n). The included studies support excellent methodological scores using the QualSyst checklist (88.1 ± 9.9%) and good psychometric scores with the COSMIN for reliability (71.1%) and moderate-to-low quality score (50%) for criterion validity. Weighted average intraclass correlation coefficients (ICCs) for intrarater reliability were highest for passive JPS and kinesthesia, ICC = 0.92 ± 0.07 (n = 214) and ICC = 0.92 ± 0.04 (n = 74), respectively. The most reliable movement and tool are internal rotation at 90° of abduction, ICC = 0.88 ± 0.01 (n = 53), and the dynamometer, ICC = 0.92 ± 0.88 (n = 225). Only 2 studies quantify an aspect of validity and no responsiveness indices were reported among the included studies.
Conclusion: Based on the results of the included studies, the evaluation of shoulder proprioception is most reliable when using a passive protocol with an isokinetic dynamometer for internal rotation at 90° of shoulder abduction. Standardized protocols addressing the psychometric properties of shoulder proprioception measures are needed.
Level of Evidence: Level 1a: systematic review.

Introduction

Proprioception is not a new concept, first introduced as our "muscular sense" by Charles Bell in 1826 and later elaborated by Charles Sherrington, who coined the term "proprioception" in 1906, as "our perception of joint movement and positioning in space in the absence of visual feedback."[1] Proprioception has evolved over time to become an overarching theme, including the subcategories of kinesthesia, the awareness of passive or active joint movement, joint position sense (JPS), the reproduction of joint angles actively or passively,[2,3] as well as our ability to detect vibrations,[4] level of force production,[5] and changes in limb or joint velocity.[6]

The role of proprioception is well depicted in the context of the shoulder joint. Due to its vast mobility, it is inherently an unstable joint,[7] relying heavily on the synchronicity of its active and passive structures for dynamic neuromuscular control.[8,9] The

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What is already known on this topic?

Proprioception has often been described as our sixth sense, which includes our ability to determine where our limbs are in space (joint position sense) and our ability to detect movement (kinesthesia). It is well established that our proprioceptive sense is intimately linked to our ability to interact with our environment without sustaining injury and is therefore increasingly of interest in rehabilitation fields, particularly at the shoulder joint. The glenohumeral joint is inherently unstable and relies heavily on neuromuscular control and proprioceptive acuity to maintain stability and ensure controlled movements. Assessment of proprioception is foundational to the identification of impairments and managing them in individual patients. A synthesis of current research addressing outcome measures can be used to establish optimal measurement approaches. The purpose of this systematic review was to identify studies which present the measurement properties of shoulder proprioception, specifically joint position sense and kinesthesia, and to synthesize the data of the presented psychometric properties (validity, reliability, or responsiveness).

What does this study add?

This study provides a comprehensive literature review addressing shoulder proprioception protocols and their psychometric properties. This review includes 21 studies and presents the calculations of weighted averages for intraclass correlation coefficients of intrasession and intersession reliability measures for shoulder proprioception protocols. This review makes preliminary recommendations on the most reliable direction of movement, method of proprioception assessment, and type of equipment used during protocols. Finally, the authors are demonstrating the overall lack of standardization for measuring shoulder proprioception, in the hope of encouraging future research on the validity, reliability, and responsiveness of protocols.

active and passive tissues contribute to proprioceptive awareness through the input provided by mechanoreceptors (Fig. 1) located within the structures of the shoulder complex.[3,10-12] Proprioception is thus the sum of neurological feedback from multifaceted systems that regulate motor control and behavior[10,11,13] and is widely recognized as being important for motor control rehabilitation and overall physical health.[14,15]

Considering its importance in healthy movement production, one may wonder if there is an association between poor proprioception and musculoskeletal (MSK) disorders. Indeed, it has been demonstrated that proprioceptive deficits are related not only to MSK injury but also to the recurrence and persistence of symptoms and disability.[16-18] This relationship suggests, first, that rehabilitation programs should aim to improve neuromuscular control and proprioceptive capacities and, second, that proprioception should be objectively measured throughout rehabilitation. Although an increasing number of studies exploring the effects of proprioceptive rehabilitation has indicated the effectiveness of this type of intervention in the treatment of MSK disorders such as ankle instability, anterior cruciate ligament reconstruction, and osteoarthritis,[19,20] other results have been less promising and indicate a need for further study.[10,19,21] The difficulty of evaluating the effects of proprioceptive rehabilitation is that the measurement of proprioception itself remains a challenge.[22,23] As proprioception has been linked to the persistence of impairments and physical limitations,[16-18] it would be advantageous to measure it objectively in a clinical setting.

The psychometric properties of protocols are important to understand to objectively quantify an individual's level of impairment, physical limitations, and/or restrictions of participation. Such qualities include strong validity, reliability, and responsiveness measures to establish the credibility and usefulness of a measure for quantifying neuromuscular function.[24-27]

The purpose of this systematic literature review was to identify and report the psychometric values of validity, reliability, and responsiveness from studies quantifying shoulder proprioception in adults, measured as JPS or kinesthesia. Presentation of this systematic review follows the recommendations outlined by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).[28]

Methodology

Literature search and study identification

A literature search was conducted by 2 reviewers (A.L.A. and M.R.) using 5 databases including PubMed (Ovid MEDLINE), Embase, CINAHL, PEDrO, SPORTDiscus, the reference system EBSCO, and a manual search of references from all retrieved articles. The search was performed from inception to July 15, 2016, and included the key terms proprioception (proprio*), kinesthesia (kinesthes*), joint position sense, clinical tool*, clinical measure*, outcome measure*, validity, reliability, responsiveness, sensitivity, specificity, and diagnostic accuracy. Combined controlled vocabulary specific to each database was used (eg, Medical Subject Headings [MeSH] for MEDLINE and Emtree for the Embase). The search strategy was developed with the guidance from a technician in documentation.

Study selection

Two evaluators (A.L.A. and M.R.) independently reviewed the titles and abstracts of each article for screening eligibility. Subsequently, the 2 raters reviewed each article, addressed the inclusion criteria, and came to a consensus for inclusion. An article was accepted for a full review if it met the following inclusion criteria: (1) reported on at least 1 psychometric property addressing either JPS or kinesthesia of the shoulder (laboratory or clinical measure); (2) written in French or English; and (3) included adult participants with or without an MSK disorder of the shoulder. An article was excluded if it referenced the psychometric properties of a previous study and if it evaluated the sense of vibration, detection of joint or limb velocities, or perceived levels of force production. Articles evaluating either JPS or kinesthesia were selected because they are the most used methods for quantifying shoulder proprioception.[29]

Data extraction and shoulder proprioception measurements

Information was extracted by 1 evaluator (A.L.A.) systematically using a standardized form, which included the population, type of proprioception investigated, evaluation methods and equipment, direction of shoulder movements, and reported psychometric values of the protocols. The information was then verified by 2 other evaluators (M.R. and A.F.B.).