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Reliability of the hand held dynamometer in measuring muscle strength in people with interstitial lung disease

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Abstract

Objective To evaluate the inter-rater and intra-rater reliability of the hand held dynamometer in measuring muscle strength in people with interstitial lung disease (ILD).

Design Test retest reliability of hand-held dynamometry for elbow flexor and knee extensor strength between two independent raters and two testing sessions.

Setting Physiotherapy department within a tertiary hospital.

Participants Thirty participants with ILD of varying aetiology were included. Twenty participants completed the inter-rater reliability protocol (10 idiopathic pulmonary fibrosis, mean (SD) age 73 (10) years, 11 male) and 21 participants completed the intra-rater reliability protocol (10 idiopathic pulmonary fibrosis, mean age 71 (10) years, 11 male).

Main outcome measures Mean muscle strength (kg). Agreement between the two raters and testing sessions was analyzed using Bland–Altman plots and reliability was estimated using intraclass correlation coefficients (ICC).

Results For elbow flexor strength there was a mean difference between raters of −0.6 kg (limits of agreement (LOA) −5.6 to 4.4 kg) and within raters of −0.3 kg (LOA −2.8 to 2.3 kg). The ICCs were 0.95 and 0.98, respectively. For knee extensor strength there was a mean difference between raters of −1.5 kg (LOA −6.9 to 3.9 kg) and within raters of −0.7 kg (LOA −3.9 to 2.4 kg). The ICCs were 0.95 and 0.97, respectively.

Conclusions Hand-held dynamometry is reliable in measuring elbow flexor and knee extensor strength in people with ILD.

Keywords: Interstitial lung diseases; Idiopathic pulmonary fibrosis; Muscle strength; Muscle strength dynamometer; Reliability and validity

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Introduction

Peripheral muscle dysfunction is a common feature of interstitial lung disease (ILD) and is considered to be an important contributor to exercise intolerance [1]. Quadriceps weakness is strongly associated with reduced exercise tolerance in patients with ILD [2–6] and is an independent predictor of peak exercise capacity in patients with idiopathic pulmonary fibrosis (IPF) [2]. Exercise training is one of the few treatments that improves exercise tolerance in ILD [7,8]. Although the mechanism of improvement in exercise capacity following exercise training is not well understood in people with ILD, it is likely that peripheral muscle adaptation is a contributor, similar to changes seen in patients with chronic obstructive pulmonary disease (COPD) [9]. Given the potential impact of skeletal muscle function on exercise tolerance and the promising effects of exercise training, skeletal muscle strength is an important component of assessment in patients with ILD.

Isokinetic dynamometry is considered a reliable and valid method in the evaluation of strength and is usually the preferred option for clinical studies [10]. Isokinetic dynamometers provide accurate assessments of dynamic and static strength through a range of movements at various velocities [10,11]. Isokinetic dynamometers have been used to evaluate peripheral muscle strength in ILD [2,3,6] and have been shown to have good retest reliability for measuring quadriceps strength in moderately severe COPD [12]. However, isokinetic dynamometers are large, expensive, non-portable, and can be time consuming to use; therefore they are used infrequently in clinical settings [10,11,13,14]. Hand held dynamometry provides a simple, inexpensive and versatile alternative for assessing muscle strength. The hand held dynamometer (HHD) fits into the palm of the hand, allowing the operator to provide direct resistance to the movement of the extremity and to measure the force output of the muscle movement [13]. Hand held dynamometry has been shown to be valid and reliable in measuring strength in healthy adults [7,13,15], community-dwelling elderly fallers [16], older adults after hip fracture [14], people with COPD [11], spinal muscular atrophy [17], neuropathic weakness [18], critically ill patients [19], people with Huntington's disease [20] and systemic lupus erythematous [21]. Moderate to good reliability was found across all patient groups with reliability coefficients ranging from 0.80 to 0.99.

Hand held dynamometry may be a useful tool for measuring and assessing changes in skeletal muscle strength in people with ILD. However, the majority of studies have been in elderly populations or people with neurological conditions or impairments and measures of reliability may be specific to the populations and testing procedures used [11]. Also rater strength can affect the reliability of HHD measurements [22] which may limit the appropriateness for practical usage in clinical settings where multiple clinicians may be involved in the assessment of skeletal muscle strength. This study therefore examined the suitability of the HHD as a tool for assessing muscle strength in people with ILD. Our aims were to evaluate the inter-rater and intra-rater reliability of the HHD in measuring muscle strength in people with ILD.

Methods

Participants

Participants with documented ILD of varying aetiology were recruited from the Department of Respiratory and Sleep Medicine at Austin Health. Sample size estimates calculated according to the method described by Walter *et al*. [23] indicated that to achieve a reliability coefficient between 0.7 and 0.9, with significance level of 0.05 between the two assessors (inter-rater reliability) and between the two separate testing sessions (intra-rater reliability), 19 participants were required. The diagnosis of ILD was made according to established criteria [24]. For IPF, the diagnostic criteria were consistent with those outlined in the International Consensus Statement [25]. Participants received written and verbal information about the study and written consent was obtained from all participants before the strength testing commenced. People were excluded if they had a concurrent and predominant diagnosis of another significant respiratory disorder (for example: asthma, chronic obstructive pulmonary disease [COPD], bronchiectasis, cystic fibrosis, or lung carcinoma) as the primary cause of their symptoms, were too unwell to attend the hospital or had any other co-morbidities, including severe orthopaedic, cardiac or neurological conditions which would prevent them from safely and accurately performing the testing protocol. All participants had consented to an ongoing randomized controlled trial examining the benefits of exercise in ILD (Australian New Zealand Clinical Trials Registry [ANZCTR] no. ACTRN12611000416998).

Procedures

Strength testing protocol

Muscle strength was measured using a HHD (Commander Power track II, Jtech Medical, UT, USA). The HDD was set to read force in Newtons (N), with an upper limit of 660 N, measuring to the nearest 0.1 N. Isometric strength of the elbow flexors and knee extensors was tested, on the participant's dominant side, using the isometric 'make' test. Make tests were employed since they are associated with lower forces [26,27] and are more reliable than break tests [26]. For a 'make' test, the HHD is stabilized in the designated position on the participant's limb. The participant is instructed to exert maximal force against the HHD for a period of three to five seconds [26], to allow maximal muscle fibre recruitment [28], and the examiner gives appropriate resistance to the muscle force generated [26]. The position of the participant and the placement of the HHD were standardized (Table 1) and the participant received standardized instructions and