



Original Research—CME

Intra-rater Reliability of Arm and Hand Muscle Strength Measurements in Persons With Late Effects of Polio

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Abstract

Background: Muscle weakness in the upper limb is common in persons with late effects of polio. To be able to measure muscle strength and follow changes over time, reliable measurements are needed.

Objective: To evaluate the intra-rater reliability of isometric and isokinetic arm and hand muscle strength measurements in persons with late effects of polio.

Design: A test-retest design.

Settings: A university hospital outpatient clinic.

Participants: Twenty-eight persons (mean age 68 years, SD 11 years) with late effects of polio in their upper limbs.

Methods: Isometric shoulder abduction, isokinetic concentric elbow flexion and extension, isometric elbow flexion, and isometric grip strength were measured twice, 14 days apart. Reliability was evaluated with the intra-class correlation coefficient, the mean difference between the test sessions (\bar{d}), together with the 95% confidence intervals for \bar{d} , the standard error of measurement (SEM and SEM%), the smallest real difference (SRD and SRD%), and Bland-Altman graphs.

Main Outcome Measurements: A fixed dynamometer (Biodex) was used to measure arm strength and an electronic dynamometer (GRIP-it) was used to measure grip strength.

Results: Intra-rater reliability was high, with intra-class correlation coefficients between 0.87 and 0.98. The SEM%, representing the smallest change for a group of persons, ranged from 7%-24% for all strength measurements, and the SRD%, representing the smallest change for an individual person, ranged from 20%-67%.

Conclusion: Muscle strength in the upper limbs can be reliably measured in persons with late effects of polio. However, the measurement errors indicate that the method is more suitable to detect changes in muscle strength for a group of persons than for an individual person.

Introduction

Many persons who were affected by poliomyelitis in their youth can experience new impairments after a stable period of at least 15 years (so-called postpolio syndrome or late effects of polio). The new impairments most commonly experienced are muscle weakness, muscle fatigue, and joint and muscle pain [1-3]. The muscle weakness often affects the lower limbs, but in approximately 60% of persons with late effects of polio, muscle weakness also occurs in the upper limbs [4]. Studies have shown that persons who had polio in the past have significantly reduced grip strength [4,5] and isometric elbow muscle strength [6,7] compared with healthy persons, which has an impact on their ability to perform daily activities with their hands [4].

In persons with late effects of polio, the decline over time in upper limb muscle strength is usually slow but varies between studies. Klein et al [8] reported a significant decline in muscle strength over a 9-month period, especially in wrist flexors and shoulder external rotators. Allen et al [7] did not find a significant decline in elbow flexor strength over a 2.5-year period despite a subjective perceived deterioration in muscle strength. Sørensen et al [9], who followed up on participants over a 15-year period, found a significant decline in muscle strength in elbow flexors and extensors, as well as in grip strength.

Because muscle weakness is one of the most common impairments in persons with late effects of polio, reliable measurements of muscle strength are important because they could help rehabilitation professionals

verify the weakness and monitor changes of strength over time. During the past decade, isokinetic and electronic dynamometers have been established as valuable tools to assess muscle strength in the upper limbs in persons with various neurologic and non-neurologic disorders [10,11]. To the best of our knowledge, only one small study [8] has investigated the reliability of muscle strength measurements in the upper limbs in persons with late effects of polio. This study included only 6 persons, and the authors used a hand-held dynamometer to measure isometric muscle strength [8]. Thus knowledge of the reliability of strength measurements in various muscles groups in the upper limbs in persons with late effects of polio is very limited.

Therefore, the aim of this study was to evaluate the intra-rater reliability of arm and hand muscle strength measurements in persons with late effects of polio. Isometric shoulder abduction, isokinetic concentric elbow flexion and extension at 60°, isometric elbow flexion at 90°, and isometric grip strength were measured twice, 14 days apart, and a comprehensive set of statistical analysis was used to evaluate the reliability.

Methods

Participants

Twenty-eight persons were recruited from a postpolio rehabilitation clinic at a university hospital in the south of Sweden. All persons met the criteria of postpoliomyelitis syndrome, as defined by Halstead and Rossi [12]. Inclusion criteria were (1) a confirmed history of acute poliomyelitis affecting their upper limbs; (2) new symptoms after a period of functional stability; and (3) the ability to understand Swedish. The only exclusion criterion was the presence of other diseases (such as stroke, Parkinson disease, or severe osteoarthritis) that could have an impact on participants' muscle strength in the upper limbs. An electromyogram had been recorded as a part of the initial routine clinical examination and verification of prior polio in participants' upper limbs (the deltoid, biceps brachii, and first dorsal interosseus muscles). After a review of the National Rehabilitation Hospital (NRH) Post-Polio Limb Classification [13] and each participant's own perception, one upper limb was defined as being "less affected" and the other as "more affected." All persons had postpolio NRH class II-V (indicating subclinical, clinically stable, clinically unstable, and severe atrophic polio, respectively) in at least one arm.

Ethics

Prior to inclusion in the study, verbal and written information about the purpose of the study was provided and each person gave his or her written informed

consent to participate. The principles of the Declaration of Helsinki were followed.

Procedure

Each participant was tested twice, 14 days apart, by the same examiner and at the same time of the day. Transport was provided free of charge to and from the test site for all participants. A summary of the study design is presented in Figure 1. First, isometric strength measurements for the less affected shoulder abductors were performed, followed by measurements for the more affected shoulder abductors. Thereafter, isokinetic and isometric strength measurements for the less affected elbow were performed, followed by measurements for the more affected elbow. Finally, isometric grip strength was measured for the less affected hand and then for the more affected hand. The total time for each test session was approximately 1 hour. At the end of the second test session, participants were given a written summary and oral information about the test results.

Measurements of Shoulder and Elbow Muscle Strength

Measurements of the shoulder and elbow were performed with the Biodex System 3 PRO dynamometer (Biodex Medical Systems, Inc, Shirley, NY; <http://www.biodex.com>) using the standard Biodex shoulder and elbow unit attachments. Before each test session, the system was calibrated to be within allowable limits set by Biodex. Maximal isokinetic muscle strength was defined as the highest peak torque and the isometric measurements as the maximal voluntary contraction (MVC). The highest values from each position were recorded in Newton meters (Nm).

The participants were seated in an adjustable chair and stabilized with straps across the shoulders and waist. The dynamometer was positioned so the joint lines were aligned with the movement axis of the dynamometer. Before each measurement, the full range of motion was set. For each participant, the details of the positions were recorded and used in the second test session. Prior to each test session, the participants

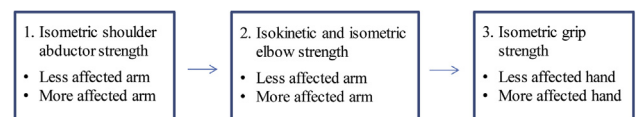


Figure 1. A summary of the study design. First, isometric strength measurements for the less affected shoulder abductors were performed followed by measurements for the more affected shoulder abductors. Thereafter, isokinetic and isometric strength measurements for the less affected elbow were performed, followed by measurements for the more affected elbow. Finally, isometric grip strength was measured for the less affected hand and then for the more affected hand.

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