

Abstract

Background: In adolescents athletes isokinetic testing is applied to describe population specific characteristics in trunk strength. However, reproducibility of trunk tests used remains unclear. Aim of the study was to evaluate reproducibility of isokinetic trunk strength testing in adolescent athletes.

Methods: Trunk strength was assessed twice in healthy adolescents (N=13; 15.9±1.7yrs; 1.73±0.10m; 69.0±17.0kg). Isometric, concentric and eccentric maximum strength measurements in rotation and flexion/extension were performed. Outcome measures were peak torque (PT; [Nm]), normalized peak torque (PT_{norm}; [Nm/kgBW]) and ratios of right/left rotation and flexion/extension. Intra class correlation coefficient (ICC), standard error of measurement (SEM), smallest real difference (SRD), Bland and Altman analysis (bias; 95%-limits of agreement (LoA)) and Test-Retest-Variability (TRV) were calculated.

Results: ICC ranged between 0.65-0.90 in rotation and 0.69-0.94 in flexion/extension. Systematic error varied between -0.15 to 12.3% (rotation) and -7.0 to 8.8% (flexion and extension). TRV in rotation ranged between 14.6-21.3%. TRV in flexion/extension, except isometric extension, was below 15%. SEM/SRD ranged between 12.6/35.0% and 24.0/66.5% in rotation and 7.2/20.0% and 17.8/49.5% in flexion/extension.

Conclusions: Results indicate acceptable reproducibility of isokinetic trunk strength measurements for adolescents in the planes tested. This pilot study indicates that maximum isokinetic trunk strength testing seems to be applicable in this special population, but needs further validation.

Level of Evidence: Level IV.

Keywords

Isokinetic – Reproducibility – Adolescents – Trunk strength

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Reproducibility of maximum isokinetic trunk strength testing in healthy adolescent athletes

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Introduction

In children and adolescents athletes isokinetic testing is often applied to describe and evaluate individual and population specific characteristics like age- or gender related changes in strength over growth and maturation [1,11,12]. Moreover, it is used to define deficits in defined pathologies, to prevent injuries as well as to evaluate effectiveness of training and therapy [25]. Previous investigations mainly focused their analysis on force capacity of the adolescent knee and/or elbow joint complex [7,8,16,17,21]. Only few studies examined trunk strength capacity [1,24]. However, trunk strength capacity is considered beneficial to compensate external forces and loads [3,18]. Among others trunk strength therefore is essential for stability and performance of the core [2,3,12,15]. Most frequently data for trunk flexion/extension measurements are reported, both for adults and adolescents [2,9,13,22,24,25]. Research on lateral flexion and rotation are quite rare and reproducibility in these two planes (lateral flexion/rotation) is insufficiently analyzed [25].

The few available studies on trunk strength performance in children and adolescents [1,24] do not report reliability of isokinetic measurements used. Nevertheless, a reliable assessment of isokinetic data is important for evaluation, conclusion and valid implications of measured strength data [6,11]. In a recent review on pediatric strength testing De Ste Croix [11] stated that test-retest-variability in isokinetic strength testing in children ranges between 5 and 10%. Furthermore, De Ste Croix [11] deduces in his review that extension movements are more reliable than flexion movements, concentric muscle action is more reliable than eccentric work and that reliability is reduced with increased testing velocity, regardless of joint tested.

Iga et al. [16] and Deighan et al. [8] reported excellent reliability of isokinetic strength testing in the knee (r = 0.95) and elbow (r = 0.97) joint in children aged 6 to 10 years. Kellis et al. [17] showed clinically acceptable to excellent reliability (ICCs 0.89 to 0.98) for both concentric and eccentric knee flexion/extension in thirteen-year-old soccer players. Carvalho et al. [7] investigated the reliability of isokinetic

Reproduzierbarkeit isokinetischer maximaler Rumpfkraftmessungen bei beschwerdefreien Nachwuchsathleten

Zusammenfassung

Hintergrund: Isokinetische Kraftmessungen werden bei Nachwuchsathleten angewandt, um populationspezifische Veränderungen zu analysieren. Jedoch bleibt die Reproduzierbarkeit dieser Messungen bei Nachwuchsathleten am Rumpf ungeklärt. Ziel der Studie war es daher die Reproduzierbarkeit isokinetischer Maximalkraftmessungen des Rumpfes bei Nachwuchsathleten zu überprüfen.

Material und Methoden: Bei 13 Nachwuchsathleten wurde im Test-Retest die maximale Rumpfkraft (isometrisch, isokinetisch konzentrisch und exzentrisch) in Rotation und Flexion/Extension gemessen ($15,9 \pm 1,7$ J; $1,73 \pm 0,10$ m; $69,0 \pm 17,0$ Kg). Messgrößen waren die absolute Maximalkraft (PT; [Nm]), die normierte Maximalkraft (PT_{norm} ; [Nm/kgBW]) und der Quotient aus links/rechts Rotation sowie Flexion/Extension. Indikatoren der Reproduzierbarkeit waren der Intraklassenkorrelations Koeffizient (ICC), der Standardmessfehler (SEM), der kleinste reale Unterschied (SRD), die Bland & Altman Analyse (Bias; 95%-Limits of Agreement (LoA)) und die Test-Retest-Variabilität (TRV).

Ergebnisse: Der ICC lag zw. 0,65 und 0,90 (Rotation) sowie 0,69 und 0,94 (Flexion/Extension). Der systematische Fehler (Bias) variierte zw. -0,15 und 12,3% (Rotation) und -7,0 und 8,8% (Flexion/Extension). Die TRV betrug in der Rotation zw. 14,6 und 21,3%. und in der Flexion/Extension, mit Ausnahme der isometrischen Extension, lag bei allen Messungen unter 15%. SEM/SRD lag zw. 12,6/35,0% und 24,0/66,5% (Rotation) sowie zw. 7,2/20,0% und 17,8/49,5% (Flexion und Extension).

Schlussfolgerung: Die Ergebnisse zeigen eine akzeptable Reproduzierbarkeit isokinetischer Maximalkraftmessungen des Rumpfes bei Nachwuchsathleten. Die Ergebnisse der Pilotstudie

knee strength testing among 14 to 16-year-old basketball players [7]. They reported an ICC from 0.72 to 0.99 for concentric and eccentric testing modes, resulting from clinical not acceptable (ICC 0.72 for eccentric mode) to clinical acceptable (ICC 0.75-0.90) and excellent (ICC > 0.90) reproducibility. To the author's knowledge, however, no study is available that reports data on the reproducibility of isokinetic trunk strength testing in adolescence.

Current research on adults analyses the reproducibility of trunk strength testing in flexion/extension measurements. Baur et al. [2] calculated clinical acceptable to excellent reliability (range ICC 0.74 – 0.91) for different testing velocities ($60^\circ/s$; $120^\circ/s$) in trunk flexion/extension of 20 healthy adults. Dervisevic et al. [10] also reported a clinical acceptable to excellent reproducibility (ICC between 0.78-0.91) of isokinetic trunk flexion/extension measurements in different velocities ($30^\circ/s$; $60^\circ/s$) and contraction modes (concentric/eccentric) in adult athletes. Dvir & Keating [13] testified partially clinical acceptable reproducibility of an isokinetic test protocol (con/ecc; $10^\circ/sec$, $40^\circ/sec$) measuring trunk extension strength in healthy men and women with women (ICCs: 0.70-0.87) showing higher ICCs than men (ICCs: 0.52-0.78).

The purpose of this study was to evaluate the reproducibility of isokinetic trunk strength testing in different planes (rotation; flexion/extension) in healthy adolescent athletes.

Materials and methods

Subjects

Fifteen active adolescent athletes out of various sports were recruited

for the study. All athletes were members of the elite school of sports or a sport club with systematic and regular training. All teenagers and their legal guardian signed informed consent before voluntary participation in the study. The study was approved by University's Ethical Commission and confirms to the Code of Ethics of the World Medical Association (Declaration of Helsinki). Subjects suffering from pain or non-compliant to complete the whole measurement protocol (e.g. dizziness during test procedure, developing low back pain during the test protocol) were excluded from the analysis. Two athletes (sport: judo), developing pain during the measurement protocol, were excluded for final data analysis due to the known influence of back pain on strength measurements [25]. Finally, 13 adolescent athletes (2 female/11 male; sports: judo=10, soccer=1, swimming=1, athletic gymnastics=1) with a mean age of 15.9 ± 1.7 yrs (height: 1.73 ± 0.10 m; weight: 69.0 ± 17.0 kg; training hours per week: 16.2 ± 8.5 h) and all free of complaints were included into final data analysis.

Instrumentation

Angular isokinetic dynamometers (Con-trex MJ-TP, Con-trex WS, Physiomed Elektromedizin, Germany) were used to assess strength capacity of the trunk. Measurements were performed for extension and flexion in a standing position (Con-trex MJ-TP, Fig. 1A). Range of motion was set from 10° extension to 45° flexion (ROM: 55°). Participants were fixed to the dynamometer with adjustable adapters at the lower leg and the knee as well as with two non-stretching belts at the hip and upper body (Figure 1A). Left- and right-sided strength capacity in trunk rotation was

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