The Reliability of a Rotational Power Assessment of the Core

Zois et al., J Athl Enhanc 2016, 5:5
DOI: 10.4172/2324-9080.1000241

Journal of Athletic Enhancement

Short Communication

A SCITECHNOL JOURNAL

The Reliability of a Rotational Power Assessment of the Core

James Zois[1*], Anthony P Sharp[2], Kaushik Talukdar[3] and John Cronin[3]

Abstract

Context: Most athletic upper-body power generation involves high levels of neuromuscular activation/coordination of a rotational nature. Therefore, it is important to assess athletic ability that replicates the rotational activity of athletes. However, a paucity of research currently measures rotational power of the core.

Objective: Establish inter-day reliability of chop and lift mean power output via a linear position transducer on rotational reliant power athletes.

Design: Controlled laboratory study.

Setting: Professional cricket training facilities.

Population: Eight male professional cricket players (age= 23±3.38 years, height= 186±10.06 cm, mass= 89.71± 8.12 kg) with a resistance (>2 years) training background volunteered to participate in the study.

Intervention: A linear position transducer was attached to the weight stack of a cable pulley system to determine the peak power outputs associated with a chop and lift movement. Assessment occurred on three occasions separated by at least seven days. Asymmetry, intraclass correlation coefficients (ICCs) and coefficient of variations (CV) were calculated and used to quantify the absolute and relative consistency of the testing procedures.

Results: The mean peak power outputs for chop and lift ranged from 404 - 494W and 277-314W respectively, the power outputs differing minimally (2.7-6.3%) between the left and right sides. Coefficients of variation of 7.4% - 19% were reported, with intra-class correlation coefficients of 0.54 - 0.94 observed between testing occasions.

Conclusion: Mean muscular power output associated with the lift assessment reported greatest reliability in well trained athletes. The asymmetry between sides was relatively small suggesting balanced multi-planar trunk development in the current throwing athletes. Equipment limitations (load related), training status and variable selection (mean or peak power) need to be considered prior to rotational assessment of the core.

It is recommended that the lift movement is utilized in rotational power assessments, or that greater familiarization is undertaken when administering the chop assessment.

Keywords

Core; Trunk; Assessment; Anaerobic; Transverse plane

***Corresponding author:** James Zois, Institute of Sport, Exercise and Active Living (ISEAL), College of Sport and Exercise Science, Victoria University, Melbourne, Australia, Tel: 61 3 9919 4643; E-mail: james.Zois@vu.edu.au

Received: July 22, 2016 **Accepted:** October 13, 2016 **Published:** October 18, 2016

Introduction

Most power measurements incorporate the lower limbs and are often linear in nature [1]. However less is known about the involvement of the upper extremities and/or the trunk musculature, as well as the rotational power of these segments. Though there is a great deal of debate as to what constitutes the core, the core in this article is said to include the spine, hips and pelvis, proximal lower limbs and abdominal structures [2]. Since the core is central to almost all sports activities, control of core strength, balance and motion should optimize upper and lower extremity function [2]. However, most core assessments are focused on isometric muscular endurance with long tension times and low loads [3]. Given that most athletic upper body power generation involves high levels of neuromuscular activation/coordination of a rotational nature [1], it is pertinent to assess athletic ability which replicates, as closely as possible, the rotational activity of an athlete. This contention provides the focus of this paper.

There is a paucity of research that has measured rotational power of the core. Andre et al. [4] quantified core rotational power using a seated cable rotation technique, the authors reporting a high intra-class coefficient (ICC) between days of 0.97, 0.94, and 0.95 at 9, 12 and 15% bodyweight respectively, in a college male and female population. A limitation of the protocol includes the use of the seated position which most likely eliminated the involvement of some of the core stabilizers such as the glutei musculature, and therefore the associated hip and pelvis musculature providing core stability in all three planes [5]. Previous investigations [6] have attempted to address this limitation by quantifying the inter-day reliability of peak power using a chop and lift technique from a half kneeling position. Moderate-to-high ICCs were reported for peak muscular power of the chop (range, 0.80-0.98) and lift (range, 0.83-0.96) between testing sessions, as well a standard error of measurement range of (34-41 W). Some of the current limitations from these studies include: i) only providing ICCs with no indication of the typical error associated with the respective assessments [4]; ii) limited to non-athletic populations which will most likely produce contrasting power profiles to that of athletic population [4,6]; iii) both males and females were included in the research [4,6] which likely influenced the magnitude of the ICCs given the heterogeneity of the population i.e. bipolar plots. Furthermore, when assessing human function, consideration needs to be given to the utility and affordability of equipment used by the practitioner to obtain the information of interest. If assessments do not satisfy such criteria, the interest and uptake of the practitioner is unlikely. Given the aforementioned limitations and the contention that the chop and lift could provide valuable information regarding upper extremity rotational power, the purpose of this study was to establish the reliability of chop and lift mean power output as measured by a linear position transducer, within a homogenous and elite athletic population which is reliant on rotational power.

Methods

Participants

Eight male professional cricket players (age=23 ± 3.38 years,

doi: 10.4172/2324-9080.1000241

height=186 ± 10.06 cm, mass=89.71 ± 8.12 kg) with a resistance training background (>2 years) volunteered to participate in the study. Players involved in the study were all competing in first-class domestic cricket teams (New Zealand). Players reporting any major musculoskeletal injuries as assessed by the team physiotherapist three months prior to the test were not included. Players were right hand dominant, and provided written informed consent to participate in the study. The ethics review board of Auckland University of Technology approved the study.

Testing procedures

A standardized general warm-up (10 minutes) comprising of low-to-moderate intensity exercises involving the hips, trunk and the upper extremities, was used to prepare the participants. Participants were then familiarized with the movements and were instructed to maintain an erect spine while performing both tests. A half kneeling position was used in this study, however, unlike previous research [6] there was no emphasis on narrow base of support, as long as the participants maintained a neutral spine throughout the movement. A low-density foam roll was used to support the weight-bearing knee for comfort (Figures 1a-1d). The resistance for the chop was 15% of the individual's bodyweight and 12% for the lift as prescribed previously [6]. The resistance used for the lift is comparatively low due to the complexity associated with the task. A cable pulley system (Life Fitness, USA) along with micro resistance plates (0.25 kg to 5 kg) and a long metal dowel (0.9 kg) was used in the assessment protocol. The chop assessment was performed prior to the lift. Subjects were instructed to provide maximal explosive effort for each test and were tested twice on each side. The average of the two attempts was used for further analysis. Procedures were replicated on three separate testing sessions, which were performed at least seven days apart (Figures 1a-1d)

Data analysis

A linear position transducer (Celesco, Model PT9510-0150-112-1310, USA) attached to the weight stack of the cable machine measured vertical displacement relative to the ground with an accuracy of 0.1 cm. Data was collected at a sample rate of 500 Hz by a computer-based data acquisition and analysis program. The displacement-time data was filtered using a low-pass 4th-order Butterworth filter with a cut-off frequency of 50 Hz, to obtain position. The filtered position data were then differentiated using the finite-difference technique to determine velocity (v) and acceleration (a) data, which were each successively, filtered using a low-pass 4th-order Butterworth Filter with a cut-off frequency of 6 Hz [7]. The force (F) produced was determined by adding the mass of the weight stack to the force required to accelerate the system mass. Following these calculations, power (P) was determined by multiplying the force by velocity at each time point ($P=F \cdot v$). Peak power was determined from the averages of the instantaneous values over the entire push-pull phase of the chop and lift (until end of movement i.e., end position as seen in Figures 1b and 1d. The external validity of the derived measurements from a linear position transducer has been assessed using the force plate as a "gold standard" device (r=0.81-0.96) [8,9].

Statistical analysis

Means and standard deviations (SDs) were calculated for all results following data collection. The two trials for all the lifts were averaged for the participants within the session, and the participant's means for each lift were averaged to provide a group mean for each testing session. Percent change in the mean (CM) was reported to indicate the differences in the average performance between days. The CV was calculated to represent absolute reliability. Relative reliability was quantified via the ICC. The level of acceptance for reliability for this study was an ICC ≥ 0.70 [10] and a CV ≤ 15% [11]. Ninety percent confidence intervals were reported for all statistical analyses. Descriptive statistics and reliability measures were computed using Microsoft Excel 2007 [12].

Results

Mean peak power outputs for the chop (range=409-494W; mean=450W) were 36% greater than the lift (range=277-314W;

Figure 1a: Chop Start.

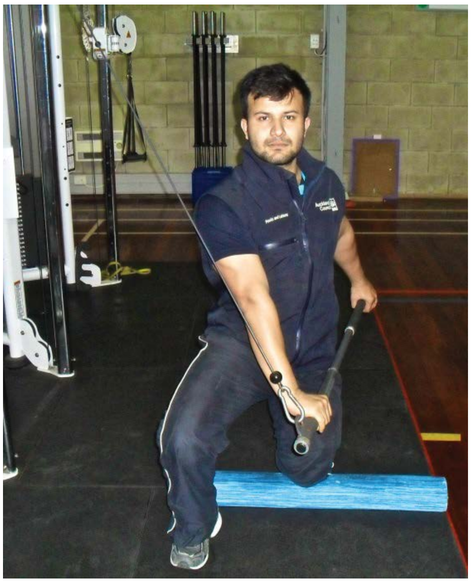

Figure 1b: Chop finish.

Figure 1c: Lift start.

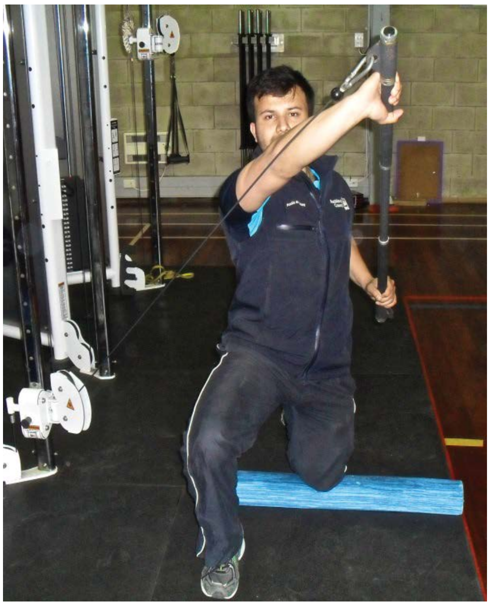

Figure 1d: Lift end.

mean=288W). The mean power output of the left side was 2.7% greater for the chop and 6.3% greater for the lift. The percent change in mean from the right-left chop assessment was between -0.2 to -11.4 W over the three testing occasions (Table 1), denoting a decrease in power output over time. The CVs ranged from 9.2% to 19% and ICCs 0.54 to 0.83 between testing occasions. There were no systematic trends observed in the data.

In terms of the lift, the percent change in the mean ranged from -10.9 to 7.4 W between days. The CVs ranged from 7.4% to 16.3% and ICCs 0.74-0.89 between testing occasions for both right and left sides. Furthermore, the lift performed on the right side (dominant side) produced greater consistency over all testing occasions i.e., variability of 2W between testing occasions (Table 1).

Discussion

The chop and lift assessment is proposed as a means to quantify rotational power in athletes. However, prior to implementing such a movement into an assessment protocol a number of factors must be taken into consideration, one of which is the reliability of the testing procedures. Previous researchers [6] have quantified the reliability of the chop and lift using a non–athletic heterogeneous population with an isotonic dynamometer. Major limitations of previous research include: samples used e.g. non-athletic male and females between 18 and 65 years of age (artificially inflating the value of ICCs); the use of isotonic dynamometer (non-specificity of the contraction type); and, limited accessibility/affordability of such equipment. Addressing these limitations, this study was the first to include professional male athletes (cricketers) and incorporate inexpensive technology commonly sourced by practitioners (i.e. a linear position transducer) to assess the reliability of this movement.

In terms of the chop, the peak power outputs observed in this study (Table 1) were higher (409 – 494 W) compared to previous research [6] – (34-395 W). A similar pattern was observed for the lift in the current study (277–314 W) compared to previously reported (181 ± 223 W) [6]. Greater mean power outputs reported in the current study could be attributed to a number of factors such as: i) athletic status of sample i.e. professional male cricketers *vs.* general population comprising both males and females aged 18-65 years; ii) equipment used to quantify rotational power – linear position transducer vs. isotonic dynamometer; and, iii) differences in approaches to calculating power output.

Interestingly the power outputs differed minimally between the left and right sides when comparing the chop and lift exercises in the current population. It was hypothesized that the athlete's previous training history in throwing and batting, as well as participants being right-side dominant may have caused preferential development of the left-side. It would seem that this was the case to some degree; left side power outputs were greater (2.7 to 6.3%) than the right side. However, whether the magnitude of this asymmetry is problematic and poses injury concerns is unknown, given the status of rotational research of the trunk.

The change in the mean is used to quantify change between testing occasions; the change attributed to random or systematic factors. It would seem that in the case of the chop there is a systematic change, as observed in a decrease in power output over the testing occasions, which is difficult to explain. This is particularly evident when the change in the mean for the lift was random and smaller in magnitude as compared to the chop. Stokes [11] stated that a common CV for biological systems is between 10 and 15%. Most of the values of our study falling within these boundaries - 9.2 - 19%, chop; 7.4-16.3%, lift. There appeared to be no systematic change in the CVs between testing occasions, suggesting no familiarization and learning effects. Previous research [6] has not reported CVs, but did report standard errors of measurement for the chop (28-34 W) and lift (41-52 W). The corresponding measures for this study were higher for the chop (37.4-61.7 W) and lower for the lift (23.6-45.6 W). The increased variability for the chop in the current study can most likely be explained by variable end-range deceleration due to the isoinertial characteristics of the system used, compared to isotonic dynamometer previously used [6]. This was not a problem with the lift due to the movement-load selection. Practitioners and researchers

doi: 10.4172/2324-9080.1000241

Table 1: Reliability of the chop and lift mean peak power outputs.

Stages	Means and Standard Deviations			Test-Retest Reliability					
	Test 1	Test 2	Test 3	Test 2-1 % Change (90% CL)	Test 3-2 % Change (90% CL)	Test 2-1 CV (90% CL)	Test 3-2 CV (90% CL)	Test 2-1 ICC (90% CL)	Test 3-2 ICC (90% CL)
Chop Left Power (W)	494 (110)	440 (106)	437 (89)	-11.3 (-24.3 to 5.5)	-0.2 (-14.6 to 16.6)	15.1 (10.5 to 35.9)	14.1 (9.7 to 33.1)	0.56 (-0.25 – 0.91)	0.60 (-0.18 – 0.92)
Chop Right Power (W)	466 (91.5)	458 (120)	409 (108)	-3.2 (-12.6 to7.5)	-11.4 (-27.4 to 9.7)	9.2 (6.2-20.5)	19.0 (13.4 to 47.3)	0.83 (0.31 to 0.979)	0.54 (0.27 to 0.90)
Lift Left Power (W)	314 (95.3)	279 (83.1)	300 (90.9)	-10.9 (-25.0 to 7.2)	7.4 (-1.0 to 17.2)	16.3 (11.4 to 39.2)	7.4 (5.0 to 16.3)	0.74 (0.07 to 0.95)	0.94 (0.72 – 0.99
Lift Right Power (W)	279 (80.5)	277 (95.7)	279(96.5)	-2.5 (-13.3 to 9.8)	0.6 (-11.4 to 14.2)	10.5 (7.2 to 23.8)	11.3 (7.8 to 26)	0.89 (0.50 to 0.98)	0.89 (0.51 to 0.98)

alike should carefully consider equipment and test/load selection in tandem with the training status of subjects for future training and testing purposes.

Reliability of testing should be a major consideration for practitioners. Vincent [10] suggested that ICC values above or equal to 0.70 may be considered reliable. All the ICCs associated with the lift assessment were above this benchmark, however only one chop ICC measurements meet this threshold (ICC=0.83). The chop ICCs reported in the current study (0.54 - 0.83) were considerably lower than those reported by Palmer and Uhl (6) - ICCs of 0.87-0.98. The disparity in results may be attributed to sample characteristics. ICCs provide insight into the change in rank order of the subjects. The subjects investigated in the Palmer and Uhl [6] studies were unlikely to change in rank order given their heterogeneity, as mentioned previously. This is evident in the data sets with standard deviations nearly half the mean, and ranges in power output from 45- 835 W. However, small changes in power output in the current study most likely depicting larger effects on rank order due to homogeneity and the smaller sample size.

Limitations

There are some limitations that the practitioner should consider before using the chop and lift as a measure of rotational power of the core. First, this study used equipment (cable pulley system) that is common in most gym environments and a linear position transducer to measure the power output of the chop and lift. Such equipment is for the most part, affordable and highly practical; can be used to measure the power of a myriad of movements. However, a limitation of many cable pulley systems is that if the load is inappropriate the weight stack will continue to move (i.e., momentum) upwards after the movement of interest is finished (e.g. chop) and sometimes "top-out". To mitigate this, cable pulley systems that address such movement artifact can be purchased, or the use of other types of resistance (e.g. pneumatic) could provide a more suitable alternative. Second, and related to the first consideration, is the choice of the load to be used for the sample of interest. The loads used in previous research were seemingly too light for the athletic population of the current study. Therefore, profiling across a spectrum of loads prior to the assessment of rotational power is recommended and is an important outcome of this research. Finally, is the choice of the outcome variable of interest and whether the power at one point in time (peak power) or across the entire movement (mean power) best represents the rotational power of an individual? To answer this question, further research is required to correlate mean and peak power to the rotational movement of interest e.g. golf swing.

Conclusion

The lift assessment has shown acceptable reliability between days and therefore can be used by practitioners in evaluating and developing upper extremity/trunk strength and power in athletic populations. However, the chop assessment has shown high variability between days in this study and therefore requires further investigation regarding choice of load (mass), equipment design, familiarization and technique. Future research should focus on establishing the optimum load for the chop assessment in athletic populations, as the 15% load for the chop appeared too light for professional cricketers in the current study. In addition, careful consideration needs to be given to equipment constraints in relation to the anthropometry of the sample of interest. Researchers may consider exploring movement's that are confined to trunk movement only, allowing less involvement of the distal segment, which in turn should decrease the movement variability and isolate trunk contribution. Additionally, the use of pneumatic air resistance compared to a standard cable pulley could provide a significant advantage in avoiding excessive end-range deceleration. Pneumatic machines (i.e., Keiser functional trainers) offer constant resistance and can be micro-loaded easily with no additional weight plates attached, providing more convenient and potentially less restrictive testing of upper extremity/ trunk power, compared to a standard cable pulley.

References

1. Stockbrugger BA, Haennel RG (2001) Validity and reliability of a medicine ball explosive power test. J Strength Cond Res 15: 431-438.
2. Kibler WB, Press J, Sciascia A (2006) The role of core stability in athletic function. Sports Med 36: 189-198.
3. Carter JM, Beam WC, McMahan SG, Barr ML, Brown LE (2006) The effects of stability ball training on spinal stability in sedentary individuals. J Strength Cond Res 20: 429-435.
4. Andre MJ, Fry AC, Heyrman MA, Hudy A, Holt B et al. (2012) A reliable method for assessing rotational power. J Strength Cond Res 26: 720-724.
5. Voight ML, Hoogenboom BJ, Cook G (2008) The chop and Lift Reconsidered: Integrating Neuromuscular Principles into Orthopedic and Sports Rehabilitation. N Am J Sports Phys Ther 3: 151-159.
6. Palmer TG, Uhl TL (2011) Interday reliability of peak muscular power outputs on an isotonic dynamometer and assessment of active trunk control using the Chop and Lift tests. J Athl Training 46: 150-159.
7. Winter DA (1990) Biomech Motor Con Hum Move. New York: Wiley, USA.
8. Cronin JB, Raewyn HD, McNair PJ (2004) Reliability and validity of a linear position transducer for measuring jump performance. J Strength Cond Res 18: 590-593.
9. Chiu, Loren ZF, Schilling, Brian K, Fry (2004) Measurement of resistance exercise force expression. J Appl Biomech 20: 204-212.

doi: 10.4172/2324-9080.1000241

10. Vincent WJ (1994) Statistics in Kinesiology. Human Kinetics.
11. Stokes M (1985) Reliability and repeatability of methods for measuring muscle in physiotherapy. Physiother Theory Pract 1: 71-76.
12. Hopkins WG (2013) Reliability from consecutive pairs of trials. In: Sportscience: A Peer- Reviewed Journal and Site for Sport Research.

Author Affiliation

Top

[1]Institute of Sport, Exercise and Active Living, College of Sport and Exercise Science, Victoria University, Melbourne, Australia

[2]Strength and Conditioning Specialist High Performance, Auckland Cricket Association, Auckland, New Zealand

[3]Sport Performance Research Institute New Zealand, Auckland University of Technology, New Zealand