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# Is the unilateral Closed Kinetic Chain Upper Extremity Test appropriate to characterize functional upper extremities asymmetry in athletes? A preliminary study

Thomas De Sousa \*

*Universite Claude Bernard Lyon 1, LIBM, Inter-University Laboratory of Human Movement Sciences, UR 7424, F-69622 Villeurbanne, France.*

Yoann Blache

*Universite Claude Bernard Lyon 1, LIBM, Inter-University Laboratory of Human Movement Sciences, UR 7424, F-69622 Villeurbanne, France.*

Isabelle Rogowski

*Universite Claude Bernard Lyon 1, LIBM, Inter-University Laboratory of Human Movement Sciences, UR 7424, F-69622 Villeurbanne, France.*

**\*Corresponding author.** Email: thomas.de-sousa@univ-lyon1.fr

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## 1. Introduction

The Closed Kinetic Chain Upper Extremity Test (CKCUEST) was introduced for assessing the upper extremity (UE) closed kinetic chain function (Goldbeck and Davies, 2000). From a push-up position, the test requires to alternatively touch the floor outside the stance hand with the other hand during 15-s periods. The outcome measure is a number of touches reflecting the combined performance of both UE. While recommended for overhead athletes (Schwank et al., 2022), the performance of the CKCUEST seems however unsuitable to exhibit bilateral UE asymmetry. Alternative approach is therefore needed to assess potential asymmetry in the UE closed kinetic chain function.

Various unilateral physical performance tests have been suggested to compare the performance of the UE (Barbosa, et al., 2023). Recently, Weon et al., (2021) introduced the unilateral CKCUEST, wherein the participant maintains the same stance UE, while performing touches solely with the other hand. Despite, healthy participants showed similar performance for both their UE, it can be thought the unilateral or bilateral nature of sport may influence the unilateral CKCUEST performance. Indeed, practicing unilateral sport, such as tennis, results in side-to-side functional asymmetries (Gillet, et al., 2017); while

practicing sport involving both UE, such as rugby, leads to bilateral functional balance (Edouard et al., 2009). Consequently, athletes presenting potential UE asymmetry may use different motor strategies to achieve the CKCUEST performance with dominant (DOM) and non-dominant (NDOM) UE.

This preliminary study aimed to determine whether the unilateral CKCUEST was suitable to assess bilateral UE asymmetry in athletes. It was hypothesized that tennis players would demonstrate higher scores when performing the unilateral CKCUEST on the NDOM UE, while rugby players would achieve similar scores for both their UE.

## 2. Methods

Four right-handed male athletes (age:  $19.2 \pm 1.5$  yrs; height:  $177.5 \pm 3.0$  cm; mass:  $66.3 \pm 13.6$  kg; sports: tennis (2), rugby (2)) participated in the study (ethical committee #2022-10-13-002). Inclusion criteria were being aged from 18 to 35 years, and practicing sport activity involving at least one UE. Exclusion criteria were having injured in the 6-months before the study or undergone surgery at one UE.

Two tapes were placed on two force plates (Bertec Corporation, Ohio, USA), spaced at one-half participant's arm span (Degot et al., 2019). The task consisted of touching the ground outside the stance hand with the same moving hand, as fast as possible. After a familiarization set, the participant performed three 15-s sets of maximal effort under verbal encouragement, interspersed by 45-s recovery. The starting stance UE was randomized, and 15-min recovery was defined between the two procedures.

The performance was the CKCUEST score, i.e. mean number of touches during the 2<sup>nd</sup> and 3<sup>rd</sup> sets. To determine the total amount of force exerted by the moving hand, the integral of the ground reaction force norm over time, for the 2<sup>nd</sup> and 3<sup>rd</sup> sets, was computed, summed, and then divided by the total number of touches performed during these two sets to represent the total impulse of the moving hand.

## 3. Results and discussion

On average tennis players performed  $19.7 \pm 2.0$  and  $19.7 \pm 2.0$  touches for DOM and NDOM procedures, respectively, while  $22.5 \pm 3.6$  and  $21.0 \pm 2.1$  touches for DOM and NDOM were recorded for rugby players. For all players, the differences in the number of touches between UE was lower than the intra-individual variability, meaning that no differences in performance were observed between sides (Table 1). The impulse of the moving hand was between 4% and 8% higher for DOM than for NDOM in tennis players, while it was between 18% and 50% lower for DOM than for NDOM in rugby players (Table 1).

Surprisingly, this asymmetry was not evidenced neither through the CKCUEST score nor the impulse of moving hand, which appeared similar during DOM

and NDOM procedures. These results suggest that the DOM and NDOM UE were involved similarly in tennis players during the unilateral CKCUEST.

Rugby practice involves both the UE, leading to bilateral balance in shoulder muscle strength (Edouard et al., 2009). The similar CKCUEST score between both UE in our rugby players suggested that they may display symmetrical UE closed kinetic chain function. However, these same scores were achieved based on different amounts of moving hand impulse between UE. These findings suggested that similar unilateral CKCUEST performances for both UE may be achieved through different UE motor strategies.

The main limitations of this study were the low sample size, and the possible influence of other factors involved in the performance, as the contribution of the lower limbs. Further studies including more participants and focusing on the moving hand impulse by component and the role of the forces produced by the feet are needed to better understand the motor strategies to perform touch during the unilateral CKCUEST.

**Table 1.** Mean CKCUEST score [set 2 - set 3] and impulse of the moving hand during the dominant (DOM) and non-dominant (NDOM) unilateral procedure of the CKCUEST.

	Score (n)		Impulse (N.s)	
	DOM	NDOM	DOM	NDOM
Tennis_1	18[0]	19.5[3]	70.96	64.93
Tennis_2	21.5[1]	20[4]	64.22	61.90
Rugby_3	19.5[1]	19.5[-3]	50.02	58.93
Rugby_4	25.5[3]	22.5[-1]	33.43	50.00

#### 4. Conclusions

This study showed that the unilateral CKCUEST seemed inappropriate for assessing the functional UE asymmetry in athletes, since similar performances for the UE were related to different underpinning biomechanical mechanisms.

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#### Conflict of Interest Statement

The authors report no conflict of interest.

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