# Reliability of Electromyographic Assessment of Biceps Brachii and Triceps Brachii in Cricketers

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## Abstract

**Objective:** The purpose of this study is to determine the intraexaminer and interexaminer reliability of electromyographic assessment of biceps brachii (BB) and triceps brachii (TB) muscles in cricketers.

**Methods:** Sixteen healthy male cricketers (ages 14-35 years) recruited from Jamia Millia Islamia, New Delhi, India were tested on 2 occasions that were held 1 week apart. On the first occasion, only examiner 1 performed the testing; on the second occasion, examiner 1, examiner 2, and examiner 3 all performed testing. While testing for surface electromyography (sEMG) activity of BB and TB muscles, participants were asked to produce maximal voluntary isometric contraction (MVIC), which was to be held for 5 seconds against the resistance provided by an examiner. Participants performed 3 MVICs per muscle per examiner, with a rest interval of 3 minutes between consecutive contractions. Intraclass correlation coefficient, standard error of measurement, and minimum detectable change were calculated to determine the reliability of repeated sEMG measurements.

**Results:** Nonsignificant differences were observed for the 2 trials completed by examiner 1 (paired *t* test) and testing done by all 3 examiners (repeated measures analysis of variance) at $P < .05$ for both BB and TB. Intraclass correlation coefficient values ranged from .84 to .86 for BB and .89 to .98 for TB. Standard error of measurement (minimum detectable change) was .052 (.144) mV and .041 (.114) mV for BB intraexaminer and interexaminer reliability testing, respectively, and .018 (.051) mV and .043 (.119) mV for TB intraexaminer and interexaminer reliability testing. Ninety-five percent of the mean differences between almost all of the repeated measurements were found to lie within the agreement intervals estimated by Bland-Altman plots.

**Conclusion:** This preliminary study suggests that sEMG is a reliable tool with excellent intraexaminer and interexaminer reliability for assessing the activity of BB and TB muscles in male cricketers. These findings suggest that sEMG can be used to assess MVIC activity of these muscles in clinical settings, as well as in research area. (J Chiropr Med 2018;xx:1-xxx)

**Key Indexing Terms:** *Reproducibility of Results; Upper Extremity; Electromyography*

## Introduction

Surface electromyography (sEMG) being noninvasive in nature finds its use in a wide range of research and clinical applications for quantification of muscle activation during isometric and dynamic conditions.[1-6] It records the action potentials generated by active motor units at the skin surface.[5] It has been proven to be a reliable method for the assessment of activity of upper limb muscles,[7,8] lower limb muscles,[1,9,10] paraspinal muscles,[10-12] and abdominal muscles.[10]

Moderate to very high reliability between the testing sessions (intraclass correlation coefficient [ICC] = 0.7-0.97) has been reported for quadriceps muscle when tested isometrically[1] and during dynamic activities such as vertical jumping.[9] Excellent test-retest reliability for repeated sEMG testing of abdominal and lower extremity muscles during bridging and quadruped exercises were also found (ICC = 0.86-0.93).[10] Moderate to very high reliability (ICC = 0.6-0.98) for interday and intraday sEMG testing of lumbar paravertebral muscles has been reported while performing different exercises that are beneficial in back rehabilitation programs.[11] These results were further supported by the findings of Ahern et al,[12] who showed repeated lumbar paraspinal sEMG testings to be reliable with Pearson's correlation coefficients, ranging from 0.66 to 0.97 for within-session reliability and 0.26 to

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0.92 for between-session reliability during static and dynamic movements. Intraday and interday reliability of scapular and arm muscles' sEMG amplitude values, including biceps brachii (BB) and triceps brachii (TB), were found to be excellent (ICC > 0.75) and good to excellent (ICC = 0.41-0.98), respectively, while performing closed kinematic chain exercises, such as wall press, bench press, and push-ups on stable and unstable surfaces in healthy adult men.[7]

The majority of research pertaining to the reliability of sEMG data of upper limb muscles has been completed on a healthy, nonathletic population. Furthermore, sEMG is a frequently used assessment tool for investigating upper limb muscle activity in various sports science research.[1,13-19] Electromyography (EMG) activity of elbow flexors and extensors has been assessed in different studies on baseball players,[19] triathletes,[17] swimmers,[17] bodybuilders,[18] and cricketers,[13-15] with recent studies being predominantly conducted on cricket players in whom muscle activity during bowling has been investigated. Bowling is an overhead throwing action that requires functioning of many muscles of upper limb, of which BB and TB play a crucial role.[13-15] Biceps brachii muscle causes elbow flexion during the cocking phase and contracts eccentrically to control elbow extension and also prevents glenohumeral joint distraction and anterior subluxation during the deceleration phase of throwing.[16] Triceps brachii muscle initially contracts eccentrically during the cocking phase to control elbow flexion and later causes elbow extension both during this phase and later during the acceleration phase.[16]

In addition to determining the dynamic activity of BB and TB muscles, previous studies have also assessed the maximal voluntary isometric contraction (MVIC) activity of these muscles for normalizing the EMG values.[7,14] Maximal voluntary isometric contraction is one of the most common measures used for normalization, which is required for comparison of EMG data across different points, among different participants and between different muscles[2,20,21] to improve muscle activation levels and reliability of EMG data.[21,22] Kaplanis et al[5] showed nonsignificant differences in the results of repeated intraday sEMG testing of BB muscle at 10%, 30%, 50%, 70%, and 100% of MVIC, thus indicating that reliable results were recorded for MVIC testing of BB muscle after a period of time had elapsed, whereas Rota et al[23] found poor between-day reliability with ICC values of 0.36 and 0.41 for BB and TB muscles' MVIC activities in male tennis players. The conflicting findings warrant further investigation and lead us to speculate that sEMG reliability varies across different populations.

Despite frequent research being conducted on investigating BB and TB muscle activities, an investigation into the reliability of BB and TB sEMG assessment has not been reported previously in cricket players. Cricket, being a professional multimillion dollar sport, is the second most popular sport played worldwide after soccer.[24,25] As of now, more than 100 countries have been recognized by the International Cricket Council.[24] Because of its varied match formats (ie, test and 1-day) and the advent of a new game format (ie, Twenty20), the sport is gaining more and more popularity each day.[26,27] It thus becomes imperative to establish the reliability of electromyographic assessment of BB and TB muscles in cricketers to ascertain the viability of sEMG methodology in clinical and research settings. The objective of this study was to evaluate the intraexaminer and interexaminer reliability of sEMG assessment of BB and TB muscles in cricketers.

## Methods

### Participants and Examiners

Sixteen healthy, interuniversity male cricket players (3 batsmen, 2 medium pace bowlers, and 11 all-rounders), aged 14 to 35 years, from Jamia Millia Islamia, New Delhi, India, volunteered for the study. Out of 16 players, 14 participated in the intraexaminer reliability testing (age: 21.1 ± 6.1 years, height: 173 ± 3.8 cm, weight: 65.5 ± 8.1 kg), and 15 participated in the interexaminer reliability testing (age: 22.5 ± 6.3 years, height: 173.6 ± 3.9 cm, weight: 65.2 ± 7.5 kg). All of the players were in the in-season phase of their macrocycle. The players used to play at in-fielding and out-fielding positions (they were not restricted to a single fielding position) and primarily used the overhead throwing technique during fielding activities. Only participants having at least 4 years of previous cricket experience were chosen. It was made sure that the participants were free of any upper limb injury, acute pain in the upper limb, and fatigue. The participants were informed about the research procedure and were asked to sign the consent form. This study was given ethical clearance from the Jamia Millia Islamia Ethical Committee to carry out this research study. There were 3 examiners who were physiotherapists (1 man, 2 women) by profession, having 3 to 5 years of clinical experience, using sEMG as a routine assessment method for examining muscle activity on patients with neuromusculoskeletal disorders.

### Skin Preparation and Electrode Placement

If required, the participant's skin surface was shaved to remove all hair before placing the electrodes on the skin.[17,18,23,28,29] Also, the skin was gently abraded and prepared using an alcohol swab to lower down the skin impedance (typically less than 10 kilohm) so that the action potentials generated by the muscle fibers can be picked up easily by the electrodes at the skin surface.[17,18,23,28,29]

It was ascertained that the same examiner applied the electrodes every time during the testing. Disposable bipolar surface electrodes (Ag or AgCl) that had a diameter of 1 cm were placed in line with the muscle fibers in accordance