# WITHIN-SESSION RELIABILITY OF THREE METHODS OF ELECTROMYOGRAPHY NORMALIZATION FOR HAMSTRING AND GLUTEAL MUSCLES

S. Ross[1,2], P. Comfort[2,3], N. J. Ripley[2], M. Cuthbert[2,4], J. J. McMahon[2]

[1]Edge Hill University, Ormskirk, UK; [2]University of Salford, Greater Manchester, UK; [3]Leeds Beckett University, Leeds, UK; [4]The Football Association, Burton Upon Trent, UK

## INTRODUCTION

Several methods have been proposed for the normalization of electromyography (EMG) data to a value obtained from a maximal isometric voluntary contraction (MVIC). However, there is no clear consensus on normalization methods and each method is associated with varying degrees of reliability. The aim of the current study was to establish within-session reliability of three MVIC methods for the normalization of EMG data.

## METHODS

Ten healthy resistance-trained participants (Age: 23.1 ± 3.5 years; Height: 176.4 cm ± 6.6 cm; Mass: 79.1 kg ± 12.8 kg; 4 Female; 6 Male) volunteered to participate in this study. The MVIC methods used were; prone lying isometric hip extension (0º) and knee flexion (55º) performed on an isokinetic dynamometer[(3)] (IKD HIP, IKD KNEE); prone lying isometric hip extension (0º) and knee flexion (55º) with manual resistance[(1)] applied to the distal thigh (MAN HIP, MAN KNEE) and as a gluteal standing squeeze[(2)] (GS) and a novel hamstring standing squeeze (HS). EMG electrodes were positioned as per the SENIAM guidelines. Raw EMG data were captured at 1500 Hz, with high- and low-pass filtering between 10-1000 Hz. Root mean square values were calculated in a bespoke spreadsheet, using a 200 ms moving average window. Mean and SD were calculated across each trial relating to peak EMG amplitudes. Each participant completed three eight-second, maximal isometric contractions of both limbs across each test in a randomized order, with a 30 second rest between trials. Within-session reliability was assessed using the intraclass correlation coefficient (ICC 2,1), and coefficient of variation (CV), with acceptable reliability set at ≥0.8 and ≤12%, respectively. One-way repeated measures analysis of variance with post-hoc Bonferroni analyses, were completed to determine differences between tests.

## RESULTS

The results of the current study indicate that the MAN HIP and MAN KNEE methods of normalisation produce acceptable levels of reliability for the hamstring muscles, however the 95% CIs were broader for the MAN KNEE in the medial hamstrings. The IKD HIP method produced the greatest reliability for the gluteal muscles. There was no significant difference in EMG amplitude between any of the MAN and IKD methods for the hamstring muscles ($p$ = *>0.05; d* = 0.05 - 0.28). The HS method produced significantly lower hamstring EMG peak amplitude than any of the other methods used ($p$ = >0.05; $d$ = 0.72 - 1.0). There was no significant difference across any of the EMG amplitudes for the gluteal muscles ($p$ = > 0.05; $d$ = 0.1 – 0.25).

Table 1. Shows peak (SD) EMG across all three trials of each test condition; coefficient of variation (CV,%); intraclass correlation coefficient (ICC) with uncertainty of estimates expressed as 95% confidence intervals (CIs).

| | **Bicep Femoris** | | | | |
|---|---|---|---|---|---|
| Test | HS | IKD HIP | IKD KNEE | MAN HIP | MAN KNEE |
| Peak (SD) EMG (µV) | 144 (61) | 349 (147) | 326 (132) | 332 (127) | 349 (142) |
| CV (%) | 21.9 | 9.7 | 11.6 | 8.9 | 9.1 |
| ICC (95% CI) | .715 (.251-.907) | .972 (.939-.989) | .970 (.934-.988) | .973 (.932-.990) | .980 (.953-.993) |
| | **Medial Hamstring** | | | | |
| Test | HS | IKD HIP | IKD KNEE | MAN HIP | MAN KNEE |
| Peak (SD) EMG (µV) | 183 (67) | 322 (106) | 346 (96) | 295 (87) | 328 (82) |
| CV (%) | 11.3 | 13.2 | 11.11 | 10.6 | 9.2 |
| ICC (95% CI) | .972 (.932-.990) | .955 (.903-.981) | .908 (.791-.964) | .945 (.866-.981) | .925 (.789-.974) |
| | **Gluteus Maximus** | | | | |
| Test | GS | IKD Hip | MAN HIP | | |
| Peak (SD) EMG (µV) | 121 (83) | 177 (135) | 142 (125) | | |
| CV (%) | 16.5 | 9.8 | 16.9 | | |
| ICC (95% CI) | .887 (.650-.972) | .980 (.957-.992) | .959 (.890-.987) | | |

## CONCLUSIONS

The findings of the current study indicate that the MAN HIP and MAN KNEE methods both produce peak EMG amplitudes with acceptable levels of reliability, however the MAN HIP method should be encouraged for normalization of hamstring EMG given the broader 95% CIs associated with the MAN KNEE method. The IKD HIP method produced the most reliable method of EMG normalisation for the gluteus maximus, however it does come with considerable time implications associated with set-up and issues with accessibility to IKD for most practitioners. The MAN HIP methods could be used to normalise hamstring and gluteal EMG, however, researchers should remain vigilant of the greater CV associated with gluteal EMG.

@SRSportsTherapy

steven.ross@edgehill.ac.uk

## PRACTICAL APPLICATION

The use of manual resistance during an isometric contraction provides acceptable reliability for the normalization of EMG for the hamstring muscles, however is associated with greater CV with respect to the gluteals.

## REFERENCES

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