FIGUR8

August 24, 2019

Test-Retest Repeatability of sMMG Sensor Output

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Background of Study Application

Improved quantification of muscle balance and symmetry, key facets of neuromuscular control, could aid clinicians interested in improving activity performance, injury avoidance, and optimizing recovery from injury/surgery.

Purpose

This study evaluated intra-subject test-retest surface Mechanomyograghy (sMMG) sensor assessment of quadriceps (Quads), hamstring (HS) and gastrocnemius (Gastroc) muscle bulk displacement during a repeated unilateral partial squat (RUPS) activity.

Methods

sMMG sensors were placed bilaterally across the Quads, HS and Gastroc muscle bulks of a set of 25 subjects, 18 healthy females (21.60 ± 3.94 years) and 7 males (22.71 ± 4.79 years). Each of the muscle groups were tested during completion of the RUPS activity, a unilateral task frequently used in neuromuscular control assessment screening.

Subjects performed one practice trial and 3 data collections trials of the RUPS activity for each limb (Figure 1). Each subject stood on one leg at the edge of a 20-cm box with the contralateral limb hanging freely and hands on their hips. Subjects then completed 5 continuous single leg squat repetitions without ground contact for each trial.

Peak Quads, HS, and Gastroc muscle bulk displacements were collected during the repeated unilateral partial squat activity. Subjects performed same day re-testing sessions with an average of 10 minutes between testing. Sensors remained applied to subjects between the test sessions. Data taken from the 3rd RUPS trial for each session were used in the analyses. Statistical analyses included ICC 2-way mixed effects consistency model evaluation of intra-subject test-retest reliability.

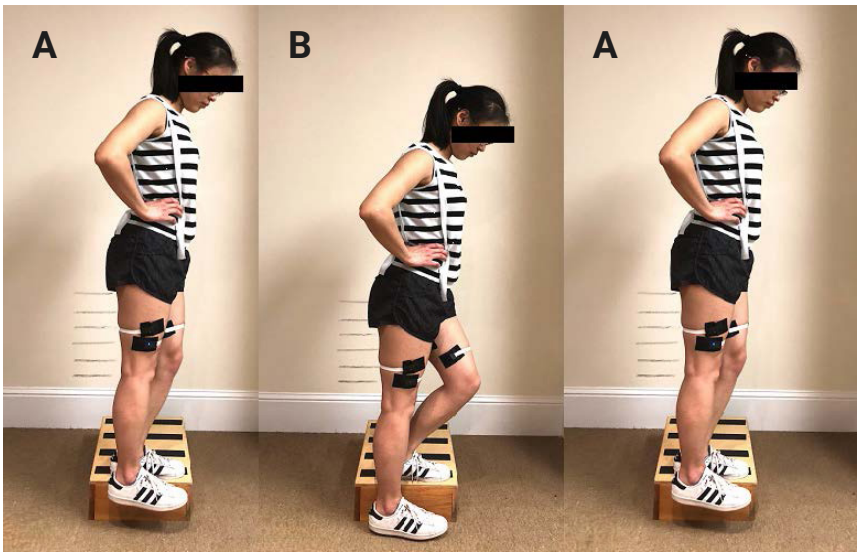

Figure 1. *Sagittal views of start (A) mid-point (B) and return to start (A) positions of one unilateral partial squat during the RUPS activity.*

Results

Quadriceps

(n= 21) peak muscle displacement displayed excellent correlation during test-retest
$ICC_{3,1}$ = 0.976 (0.934 - 0.991), p < .0001

Hamstring

(n= 21) peak muscle displacement displayed excellent correlation during test-retest
$ICC_{3,1}$ = 0.968 (0.923 - 0.987), p < .0001

Gastrocnemius

(n= 20) peak muscle displacement displayed displayed excellent correlation during test-retest
$ICC_{3,1}$ = 0.945 (0.860 - 0.978), p < .0001

Average and peak displacement for each muscle is displayed in Table 1 for both males and females.

Conclusions

The sMMG sensors demonstrated consistent detection of quadriceps, hamstrings and gastrocnemii muscle displacement with excellent test-retest reliability of peak muscle displacement during the RUPS task.

Table 1: *Average Muscle Displacement of 3 Partial Squats During the RUPS Activity.*

	Initial Test			Retest		
Muscle Bulk Displacement (mm)	**Total**	**Males**	**Females**	**Total**	**Males**	**Females**
Average Quadriceps Displacement	5.524 ± 2.575 (n=20)	7.985 ± 1.805 (n=4)	4.908 ± 2.313 (n=16)	5.873 ± 2.575 (n=20)	8.115 ± 2.870 (n=4)	5.194 ± 2.314 (n=16)
Average Hamstrings Displacement	10.235 ± 4.744 (n=21)	12.149 ± 5.413 (n=6)	9.470 ± 4.414 (n=15)	10.034 ± 4.222 (n=21)	11.525 ± 4.711 (n=6)	9.443 ± 4.027 (n=15)
Average Gastrocnemius Displacement	2.269 ± 0.924 (n=20)	2.360 ± 1.196 (n=7)	2.220 ± 0.794 (n=13)	2.266 ± 0.959 (n=20)	2.260 ± 1.151 (n=7)	2.269 ± 0.891 (n=13)

Table 2: *Peak Muscle Displacement of 3 Partial Squats During the RUPS Activity.*

	Initial Test			Retest		
Muscle Bulk Displacement (mm)	**Total**	**Males**	**Females**	**Total**	**Males**	**Females**
Average Quadriceps Displacement	5.524 ± 2.575 (n=20)	7.985 ± 1.805 (n=4)	4.908 ± 2.313 (n=16)	5.873 ± 2.575 (n=20)	8.115 ± 2.870 (n=4)	5.194 ± 2.314 (n=16)
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Figure 2. *Test vs Retest Average Quadriceps Displacement During RUPS Activity.*

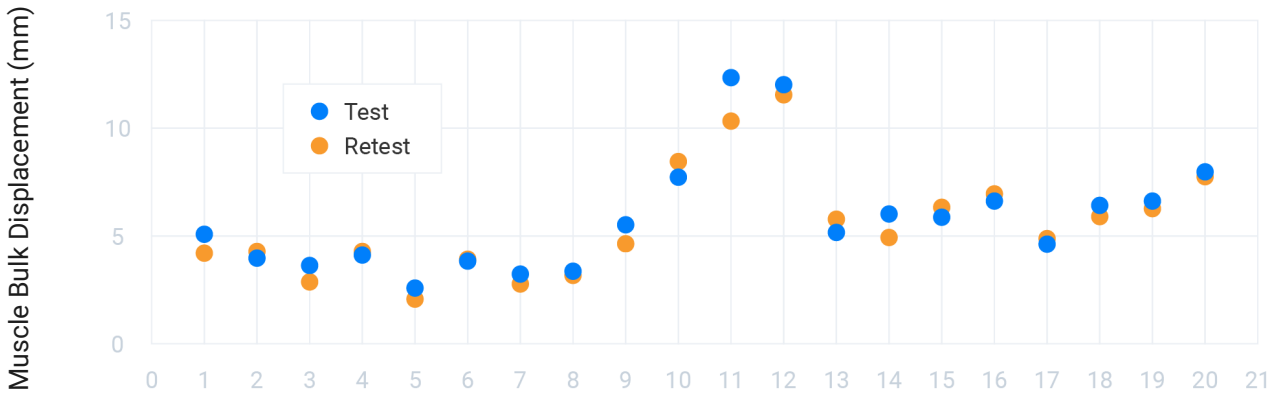

Figure 3. *Test vs Retest Average Hamstring Displacement During RUPS Activity.*

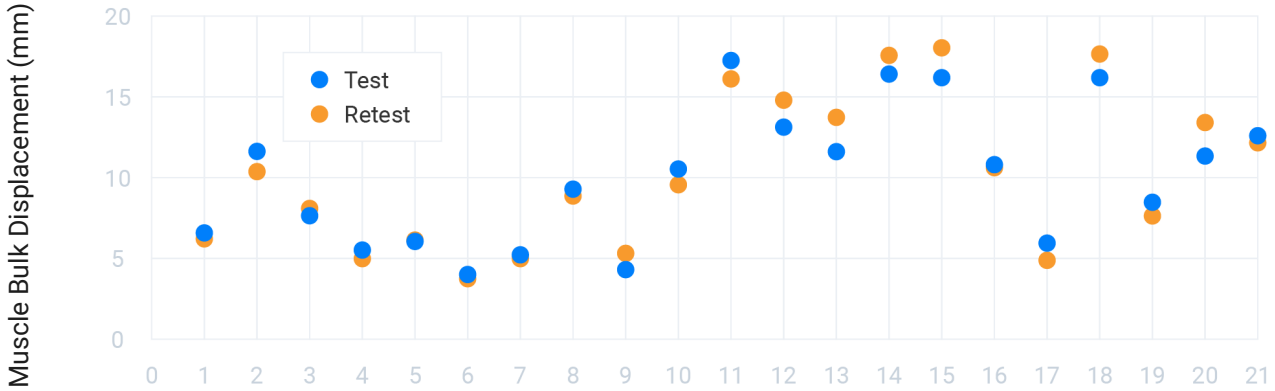

Figure 4. *Test vs Retest Average Gastrocnemius Displacement During RUPS Activity.*

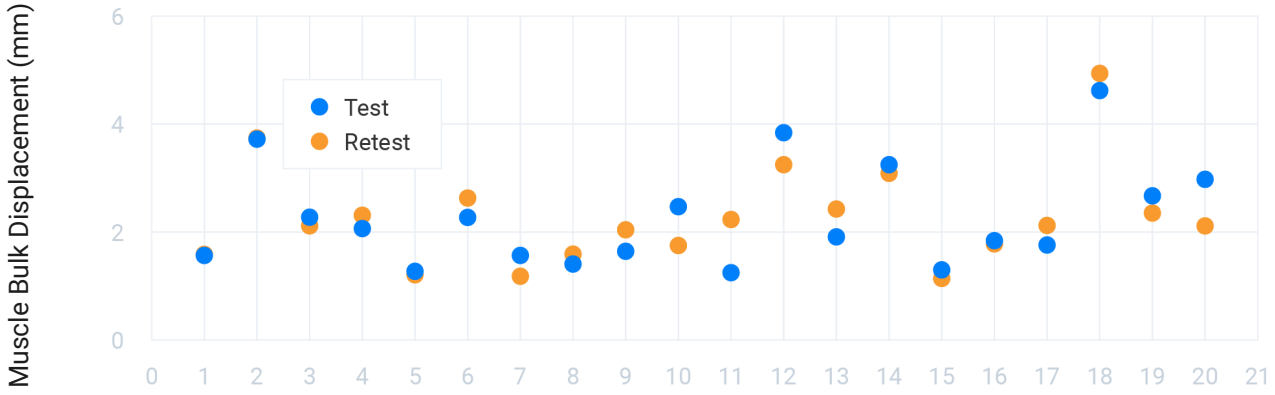

Figure 2-4. Comparison of Peak muscle displacement for initial test to retest.

Figure 5. *Difference in Test vs Retest Quadriceps Displacement During RUPS Activity.*

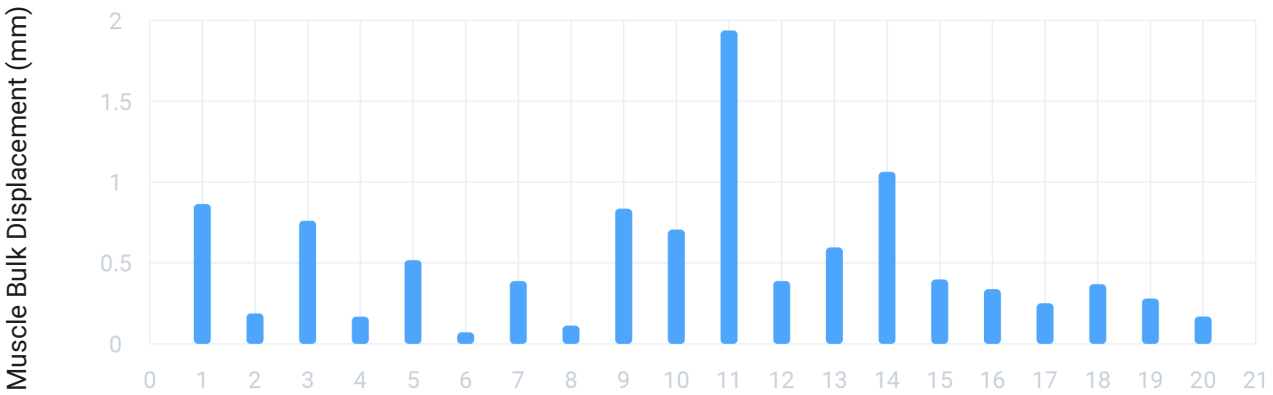

Figure 6. *Difference in Test vs Retest Hamstring Displacement During RUPS Activity.*

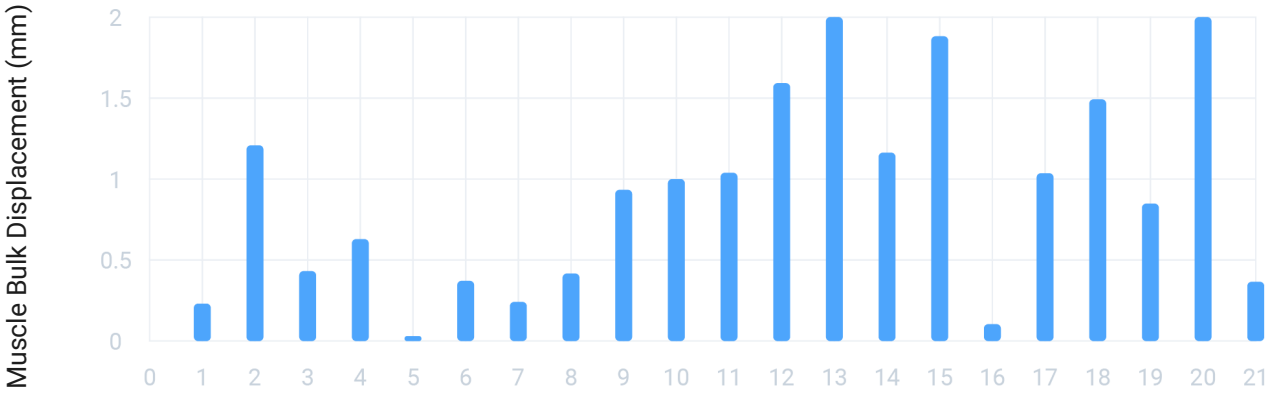

Figure 7. *Difference in Test vs Retest Gastrocnemius Displacement During RUPS Activity.*

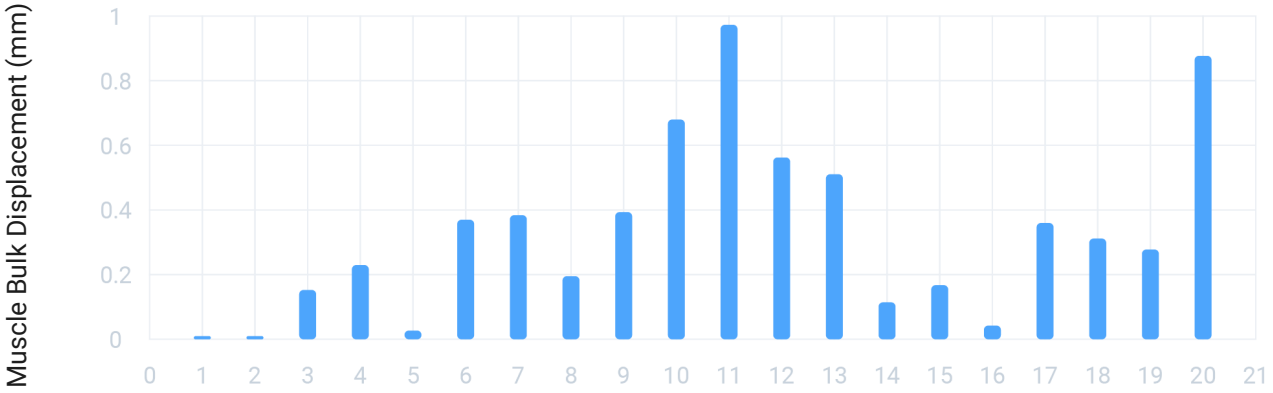

Figure 5-7. Illustrate the differences between test 1 and retest for average muscle displacement across the subjects for each muscle group.