The agreement between biofeedback measures of quadriceps and gluteal muscles in short-arc quadriceps and seated clamshell exercises.

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Background

Quadriceps and hamstring muscle activation have been established via EMG.[1] Cartilage-impaired conditions benefit from exercise interventions with clinically important pain reduction.[2,3]

Quadriceps and gluteals have pre-eminent roles in optimal knee health;[4] the short-arc quadriceps extension and clamshell exercises target these muscles.[5,6]

It is not known if introducing biofeedback to these movements would affect the profile for the gluteal and quadriceps muscles.

Bathroom scales' use as an outcome measure has been explored in respect to graded weight bearing;[7] there is potential use as a biofeedback mechanism.

Objectives

The primary study objective was to compare EMG activation of vastus medialis (VMED) and gluteus medius (GMED) muscles during SAQE and clamshell exercise, augmented with bathroom scales, to address the research question:

What is the relationship between EMG profiles when performing the seated clamshell exercise and short-arc quadriceps extension exercise with and without biofeedback?

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Methods & Materials

A prospective single-group, repeated-measures study design was adopted; participants performed hip abduction, clamshell, short arc quadriceps extension (SAQE) and isometric knee extension exercises with EMG outcome measure.

- Equipment Trigno™ Wireless EMG (Delsys Inc.); Konig KN-PS800B digital bathroom scales.

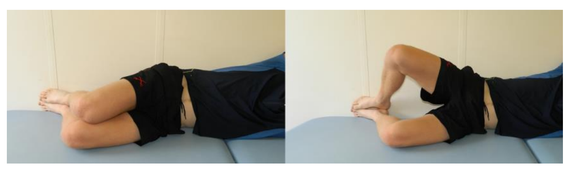
- EMG sensors placed for VMED, vastus lateralis (VLAT), gluteus maximus (GMAX) and GMED.[8]

Methods & Materials

The EMG data were captured for thigh and buttock muscles during exercise with & without bathroom scales:

Short-arc quadriceps extension

Seated clamshell



Side-lying clamshell

Two-second contraction held - prompted by the instruction to squeeze as hard as possible → 2 second rest period → repeated x 5: recording of the EMG signal was 20 seconds for each exercise.

Three maximum voluntary isometric contractions (MVIC) were elicited separately for each exercise. A control set was initially captured.

Regression and correlation (ICC & Spearman's) were calculated to explore the relationship between exercise outcome data for each muscle group.

Results

Seventeen participants – age:18 to 51 years and 47% female:

Gender M/F	Age	Height (m)	Weight (kg)	BMI (kg/m^2)
9/8	36.2 (10.1)	1.73 (0.08)	76.53 (17.6)	25.43 (4.45)

Summary statistics

Mean %MVIC values:

Clamshell: 34.13 (GMAX); 88.23 (VLAT)

Short-arc quadriceps extension: 34.76 (VLAT); 95.64(GMED)

Regression analysis:

Clamshell exercises *ST-seated, SL-side-lying*

Predictor	Dependent variable CI	R^2 adjusted
	nonbio SL GMED	
bio ST GMED	1.26 to 1.77	0.91*
nonbio ST GMED	-0.96 to -0.69	
	nonbio SL VLAT	
bio ST VLAT	-0.43 to 0.23	
nonbio ST VLAT	0.74 to 1.41	0.998*
	nonbio SL GMAX	
bio ST GMAX	-0.07 to 0.72	0.589
nonbio ST GMAX	-0.07 to 0.73	

- Highly predictive EMG activity outcomes (>90%) across the range of execution.* P<.0001

- GMED high collinearity (variance inflation factor=173).

- GMAX data demonstrated no significant association.

SAQE exercises

Predictor	Dependent variable CI	R^2 adjusted	P-value
	nonbio VMED		
bio VMED	0.47 to 0.9	0.741	<0.0001
	nonbio VLAT		
bio VLAT	0.11 to 0.44	0.423	0.003
	nonbio GMED		
bio GMED	0.05 to 1.98	0.213	0.041
	nonbio GMAX		
bio GMAX	0.94 to 1.03	0.992	<0.0001

- VMED EMG profiles were significantly related with 74% of variance accounted for (between the exercises).

- GMAX demonstrated the strongest significant association (99%) between two modes of SAQE execution.

- VLAT and GMED showed low but significant relationships.

Correlation analysis:

EMG Intraclass Correlation Coefficient (ICC)

Exercise	Muscle	Position	ICC	CI	P-Value
Clamshell	GMED	ST* & SL	0.67	0.26 to 0.87	0.004
		ST*	0.91	0.75 to 0.97	<0.0001
SAQE	VMED	ST*	0.92	0.77 to 0.97	<0.0001

Correlation analysis:

GMED demonstrated high ICC for seated and side-lying variants of clamshell.

Seated versions, with and without biofeedback, produced the highest significant correlation (>90%).

The SAQE exercise had similar ICC for VMED muscle.

Conclusions

Main findings provided evidence that EMG data were consistent and predictable when comparing the exercises with, and without, biofeedback.

Suggestion is that scales can be introduced to complement home-based knee exercises.

This simple objective physical measure could facilitate confidence in physical activity management for cartilage-impaired populations.

This measure also has potential practical application for pragmatic clinical assessment of patients in various settings.

Further research should examine the suitability of this form of biofeedback within a domiciliary rehabilitation exercise programme.

References

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