NEUROMUSCULAR INEFFICIENCY IMPAIRS MUSCLE PERFORMANCE IN HOSPITALIZED PATIENTS: A FES CYCLING-BASED EVALUATION METHOD OBSERVATIONAL STUDY

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INTRODUCTION

- Acquired muscle weakness is a prevalent complication during hospitalization.
- Functional electrical stimulation cycling-based evaluation is a safe and feasible muscular assessment method for hospitalized patients.
- Aim: to investigate a possible relationship between neuromuscular efficiency and muscle performance in hospitalized patients through a FES cycling-based evaluation method.

METHODS

Study Design

- This is a retrospective observational study;
- Data from individuals over 18 years of age, of both sexes, and who were admitted to the Intensive Care Unit – ICU or a high complexity ward were included;
- The sample size calculation indicated a minimum of 29 patients data. Data from 49 hospitalized patients with clinical sings of muscle weakness were analysed
- The participants underwent a single muscular evaluation using FES-cycling equipment.
- The equipment was set to evaluation mode. Muscle performance was assessed through torque and power output data, and neuromuscular efficiency was assessed using stimulation cost data;
- Previously published data from healthy individuals were used to establish the reference (cut-off) values for low or normal muscle performance and neuromuscular efficiency (torque = 6.03Nm, power output = 6.35W and stimulation cost = 3.41 µC/W x 10^3) (1).

FES-cycling muscle assessment protocol



- Self-adhesive electrodes were placed bilaterally on the belly of the quadriceps (vastus lateralis and vastus medialis), hamstrings, and tibialis anterior muscles
- The FES (biphasic, interval, rectangular shape pulse) was set to the same pulse width and intensity in all eight channels to promote the highest pain tolerable muscle contraction;
- The equipment was set in the evaluation mode to perform an automatic preset combination of different cycle ergometry cadences (10, 15 and 20 RPM) and electrical stimulation frequencies (50, 75 and 100Hz), maintaining the previously selected pulse width and intensity throughout the evaluation protocol. The patients performed 7 cycling movements in each combination (9 combinations, 63 cycling movements in total).
- The patients did not make any voluntary effort. All the work was performed by the FES-cycling equipment;
- The equipment recorded torque and power output, in addition to the stimulation cost.

Statistical analysis

- Shapiro-Wilk test, Spearman correlation, multiple linear regression, Fisher's exact test, sample size calculation.

REFERENCE

1- Figueiredo TG, Frazão M, Werlang LA, Peltz M, Sobral Filho DC. Functional electrical stimulation cycling-based muscular evaluation method in mechanically ventilated patients. Artif Organs. 2024;48(3):254-62

RESULTS

Table 1: Patients and evaluation basic characteristics.

Variable	
Age (years)	63 ± 15
Gender (M/F)	27/22
Intensive Care Unit patients (%)	61
Ward patients (%)	39
Pulse intensity (mA)	100 [65-130]
Pulse width (µs)	500 [500 – 600]
Torque (Nm)	3.21 [2.09 – 4.72]
Power output (W)	5.95 [2.89 – 6.91]
Stimulation cost (µC/W x 10^3)	9.48 [4.88 – 23.74]

mA, milliamps; Nm, Newton meter; W, Watts; µC/W, microcoulombs per watt. Data are presented as means ± standard deviation and median [interquartile range].

Table 2 – Spearman correlation between neuromuscular efficiency and muscle performance.

Stimulation cost	Torque		
	r	p	95% IC
	-0.72	< 0.0001	-0.83 to -0.54
	Power output		
	r	p	95% IC
	-0.87	< 0.0001	-0.93 to -0.78

Table 3 – Multiple linear regression for muscle performance.

Torque	R^2	β for age	SE	p	95% CI
	0.29	0.02	0.02	0.4962	-0.03 to 0.06
		β for stimulation cost	SE	p	95% CI
		-5.68	1.35	0.0001	-8.39 to -2.96
Power output					
	R^2	β for age	SE	p	95% CI
	0.37	-0.01	0.03	0.7484	-0.07 to 0.05
		β for stimulation cost	SE	p	95% CI
		-7.92	1.69	<0.0001	-11.32 to -4.52

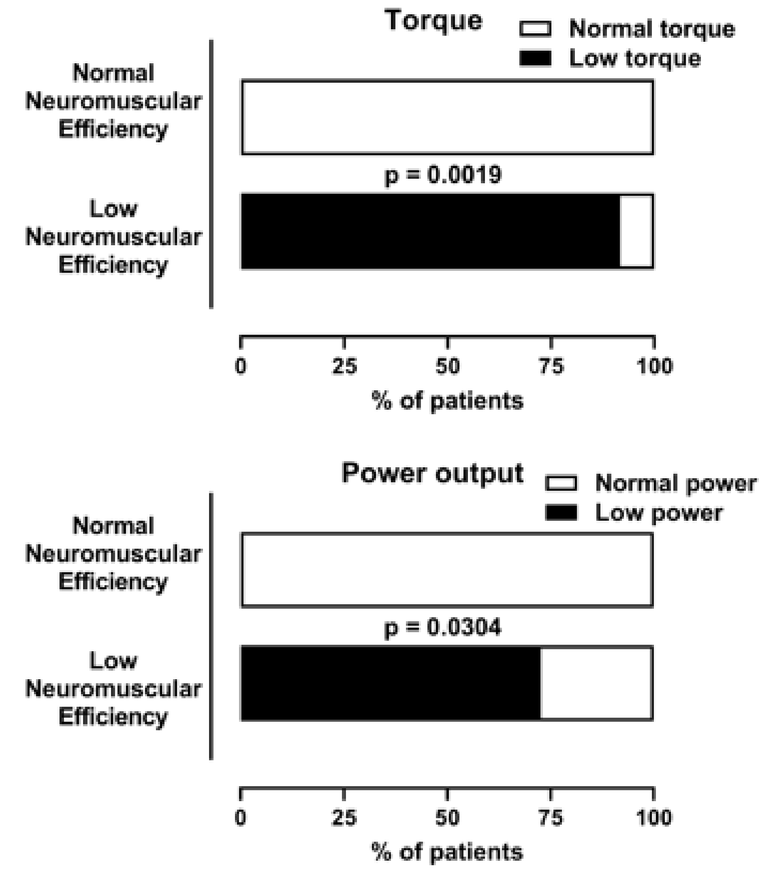


Figure 1: Percentage of patients with normal/low neuromuscular efficiency and muscle performance.

CONCLUSIONS

There is a relationship between neuromuscular efficiency and muscle performance in hospitalized patients. An association was observed between neuromuscular efficiency and muscle performance, regardless of age. Patients with low neuromuscular efficiency presented low muscle performance and patients with normal neuromuscular efficiency presented normal muscle performance.