REPRODUCIBILITY ANALYSIS OF EMG PARAMETERS DURING STAIR ASCENT

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SUMMARY
Go up stairs is a functional activity usually reported as complaint for patients with patellofemoral pain syndrome (PFPS) because it is a movement that carries unilateral weight bearing and thus cause an increase in pain. Studies that tried to characterize the stair climbing concluded that the high variability of the data does not confirm the results and suggested that more steps should be included in the staircase and reliability studies should be conducted. Studies of patients with PFPS usually suggest that there is a balance deficit in the patella stabilizer muscles and that this is the cause of pain in these patients, but there is also a great variability in the results, that does not allow to confirm this hypothesis, what can be because of the different techniques used to process the signal. In this context, this study aimed to determine which parameters of electromyographic (EMG) signals showed good reproducibility and low variability during the stair ascent and are, therefore, more appropriate to characterize this gesture. It was used a seven-degrees staircase and EMG to evaluate the activity of the vastus lateralis and medialis during stair climbing in 39 pain-free individuals and 23 individuals with PFPS. Results showed that the parameters with good reproducibility were: onset, duration of muscle contraction, median time of contraction, intensity of activation, muscular co-activation and median frequency. In order to understand changes in motor control of individuals with PFPS during stair ascent the parameters that should be used are these that were confirmed as reproducible.

INTRODUCTION
PFPS is one of the most commons knee disorders in physiotherapy clinics and can lead to serious orthopedic impairments. Go up and down stairs results in a greater overload on the patellofemoral joint and thus, is often associated with PFPS symptoms [1]. The studies that tried to understand PFPS during dynamic activities evaluated the onset of vastus medialis (VM) and lateralis (VL) activation using surface electromyography (EMG); these studies showed a greater variation in data that could not confirm the hyphotesis that the VM is delayed in relation to the VL[2]. Because of the greater variability related in other studies, the aim of this study was to analyze the reproducibility of EMG parameters to verify which parameters can be used to compare groups of individuals with or without PFPS.

METHODS

Were evaluated 39 female pain-free individuals and 23 female individuals with signal and symptoms of PFPS according to inclusion criteria frequently used in other studies [3 kuriki 2011]. Volunteers had the same anthropometric characteristics. For EMG analysis was used the ADS1000-AC1160 (Lynx®), with two pairs of Ag/AgCl surface electrodes positioned at the muscles bellies of VM and VL. To determine the actually moment that the volunteer reached the middle of the stair, a force plate (Bertec®) was positioned at the fourth step. Before any experimental procedure, all volunteers signed a written consent approved by local ethics committee.

For reproducibility analysis the same acquisitions were done in two days separated by each other for two to seven days. In the first day the muscles bellies were determined by electrostimulation and a marked in a template to be used in the second day. The first procedure was the voluntary maximal isometric contraction (VMIC) that would be used for signal normalization in the signal processing. For this, the volunteer was positioned in an extensor chair, with 90º of hip flexion and knees fixed at 45º. Then the volunteer was oriented to perform a maximal contraction during 6 seconds with verbal command. After this, the volunteer was oriented to go up a seven-degree steps in a self-controlled velocity.

EMG signal was processed in Matlab® and the parameters analyzed were: onset measured in visual, automatic and cross-correlation way, time relapsed from onset to peak signal, duration of the contraction, median time, activation intensity, muscular co-activation and median frequency. For this the signal was band-pass filtered between 20-500 Hz, the period in which the individual was over the force plate was cut and processing using the algorithms designed in Matlab.

Statistical analysis was done using SPSS for Windows, intraclass correlation coefficient (ICC), standard error of means (SEM) and minimal detectable difference (MDD) were calculated.

RESULTS AND DISCUSSION
Table 1 shows the results obtained after signal processing and statistical analyses. It can be observed that the only the time relapsed from the onset to the peak of the signal was not reproducible. So, it can be concluded that the experimental protocol and the staircase used in this study are

appropriate. Bolgla et al. (2010) analyzed the reproducibility of the onset and Cowan et al. (2000) analyzed the intensity of the signal; both studies observed good reproducibility [4,5]. This study confirms the results of those authors and detected that other EMG parameters can be used to characterize the stair ascent. For studies with the aim of understand the alterations presented by PFPS patients should be used the reproducible parameters.

REFERENCES

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Table 1: Indices of statistical analyses of reproducibility

Parâmetro	Control group			PFPS group		
	ICC	EPM	MDD	ICC	EPM	MDD
Visual Onset (ms)	0.71	5.52	15.30	-0.08	12.10	33.52
Automatic Onset (ms)	0.67	9.84	27.27	0.77	4.56	12.62
Cross correlation Onset (ms)	0.64	4.39	12.15	0.66	4.62	12.79
Automatic onset-peak time VM (ms)	0.23	21.81	60.42	0.09	37.23	103.13
Automatic onset-peak time VL (ms)	0.46	19.40	53.75	0.57	37.23	103.12
Visual onset-peak time VM (ms)	0.57	17.92	49.63	0.21	39.57	109.62
Visual onset-peak time VL (ms)	0.59	19.27	53.38	0.65	42.21	116.92
Duration VM (ms)	0.85	47.34	131.12	0.84	53.83	149.11
Duration VL (ms)	0.85	44.42	13.03	0.89	45.22	125.25
Median time VM (ms)	0.71	43.13	116.70	0.81	55.06	152.51
Median time VL (ms)	0.71	44.36	122.87	0.78	63.99	177.24
Intensity VM (un)	0.85	0.24	0.67	0.85	0.15	0.42
Intensity VL (un)	0.66	0.16	0.44	0.44	0.24	0.68
Co-activation (%)	0.72	0.03	0.09	0.93	0.03	0.09
Median frequency VM (Hz)	0.63	7.05	19.52	0.82	5.80	16.08
Median frequency VL (Hz)	0.83	6.40	17.74	0.89	5.26	14.56

* We are waiting for you in Natal, the Sun City of Brazil. Do not forget your sunscreen.