CHANGES IN MUSCLE ACTIVATION PATTERN DURING GAIT AMONG HEALTHY CHILDREN

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Introduction

Surface electromyography (EMG) is an essential part of gait analysis. It provides the objective assessment of muscular function during walking and allows to identify the timing of muscle activation during movement. Muscle activation patterns in both adults and children are normed for later use to identify movement changes, dysfunctions, or disorders [1-2]. However, it is observed that the muscle activation in children is very volatile and this is determined by the totality of external and internal factors, which is very difficult to assess. This study aims to define changes in muscle activity of children during gait and determine trends [3-5].

Methods

The study involved 13 healthy kids aged 4-11 years (6 males and 7 females). Parental consent and child assent were obtained prior to the participation in the study. Five muscles (biceps femoris – BF, semitendinosus – SE, tensor fasciae latae – TF, lateral gastrocnemius – LG and medial gastrocnemius - MG) were studied for both lower extremities. Gait was assessed under habitual pace using 8 Vicon motion capture (100 Hz), one force plate Bertec (1000 Hz) and surface EMG Delsys Trigno (2000 Hz) systems. The measurement was repeated 10 times for each subject. Gait cycle was identified using Vicon and force plate data. Collected EMG data were pre-processed: (1) filtered with a high-frequency 4th order zero-phase Butterworth filter with a 50 Hz cut-off frequency, (2) performed full-wave rectification, (3) filtered with a low-frequency 2nd order Butterworth filter with a 3 Hz cut-off frequency. Subsequently, the EMG curves were normalized to full gait cycle (from heel contact to heel contact - strides) in a random 3 strides sequence for each test and the time was normalized. Duration of muscle activation (t, %) was identified and activation change (Δ, %) were determined as the difference between the activation start and end within adjacent strides throughout the gait for each subject. Normally distributed data represented as mean ± SD and not normally distributed data – median (MAD).

Results

The time of muscle activation varies (60– 90 % of cycle) between subjects (fig.1). It may start at the beginning of one stride and end in another, and secondary muscle activation may also occur. Such activation changes presented in the table 1.

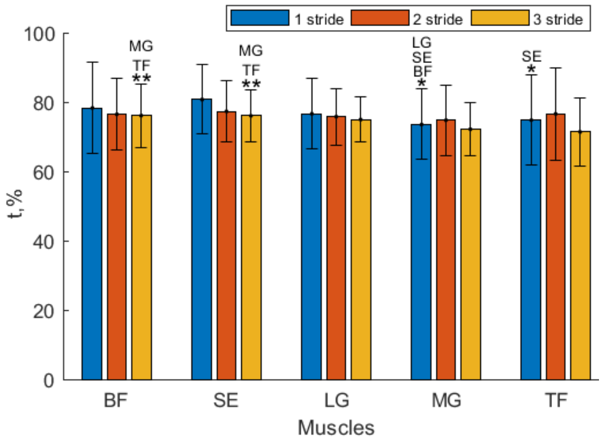

*Figure 1: t (mean± SD) of muscles in % of stride (n=13), * - in 1 stride (p<0.05); ** - in 3 stride (p<0.05);*

		1 vs 2 stride		2 vs 3 stride	
		Right	Left	Right	Left
BF	Δ_{start}	4 (5.3)	3 (3.4)	4 (4.2)	10 (6.3)
	Δ_{end}	6 (6.1)	9 (8.5)	4 (6.4)	(4.3)
SE	Δ_{start}	3 (4.9)	3 (3.4)	4 (3.8)	2 (3.3)
	Δ_{end}	5.5 (4.8)	5 (5.2)	6 (5.2)	7 (4.9)
LG	Δ_{start}	5 (4.7)	4 (2.9)	5 (3.5)	4 (3.3)
	Δ_{end}	3 (4.6)	3 (3.2)	3 (3.4)	3 (4.2)
MG	Δ_{start}	4 (4.2)	5 (4.3)	5 (4.2)	3 (3.4)
	Δ_{end}	3 (3.2)	3 (2.9)	3 (3.4)	3 (3.2)
TF	Δ_{start}	6 (4.2)	5 (4.3)	5 (3.6)	3 (4.2)
	Δ_{end}	5 (5.7)	4 (4.3)	5 (5.0)	5 (4.4)

Table 1: Activation change between adjacent strides, represented in % of stride (median (MAD)), n=13.

Conclusions and Discussion

Changes in the muscle activity pattern during gait not only define the functions of the muscle itself but also define the gait stability of the individual. On the other hand, the large variation indicates the possibilities of musculoskeletal functionality [3,5]. Our study results revealed that there is no permanent pattern of muscle activation even in normal gait of the children. However, to refine the results, the latency period of the muscle should also be taken into account and a larger number of steps should be investigated.

References

1. Rozanski et al., Clinical Neuro, 131(8):1848-1858, 2020.
2. Navacchia et al., Ann Biomed Eng, 47:2416-2430, 2019.
3. Agostini et al., Gait Posture, 32(3):285-289, 2010.
4. Bovi et al., Gait Posture, 33(1):6-13, 2011.
5. Nardo et al., Gait Posture, 46:161-6, 2016.