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Effects of cooling on muscle function and duration of stance phase during gait

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Introduction

Cold exposure alters muscular normal function. Muscle cooling influences the neuromuscular activation during maximal isometric voluntary contractions (MVC) and the amplitude of surface electromyography (sEMG) [1, 2]. It also slows down the mechanical process during contraction [3]. The purpose of this study was to investigate the effects of local cooling in cold water at 10°C for 20 min in a climate chamber on lower leg muscle activity and gait pattern.

Methods

Sixteen healthy adults (eight females), aged (±SD) 27.0 (±2.9) years participated in this experimental study. The median frequency (MF) and mean power frequency (MPF) of sEMG from tibialis anterior (TA) and gastrocnemius medialis (GM) muscles during MVC in ankle planter (PF) and dorsi-flexion (DF) against a hand-held dynamometer as well as contact times on a force plate during gait before and after cooling were measured and analysed.

Results & Discussion:

The MF and MPF was significantly lower ($P<0.01$) in both TA and GM muscle during MVC and in TA during gait trials after cooling. However, the frequency analysis for GM muscle showed no significant difference ($P=0.46$ and 0.06, respectively) either in MF or MPF during walking on level surface (table 1).

Table 1: The means and SD (Hz) for the MF and MPF of the TA and GM during gait and MVC trials before and after cooling (N=16).

sEMG	Tibialis Anterior (TA)		Gastrocnemius Medialis (GM)	
	Pre Cooling	Post Cooling	Pre Cooling	Post Cooling
Gait MF	83.0±10.2	69.9±9.6	81.6±12.6	79.3±11.1
Gait MPF	99.7±11.5	82.3±11.7	99.8±13.2	93.2±12.4
MVC MF	87.0±9.7	50.0±6.1	111.7±16.7	90.8±14.8
MVC MPF	100.7±10.6	59.8±7.7	129.1±15.3	101.0±16.1

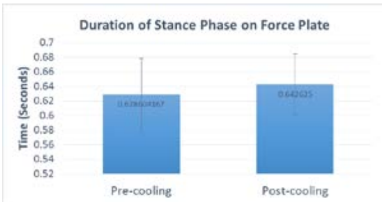

Figure 1: Duration of stance phase in gait trials.

Additionally, the post cooling stance phase over the force plate was significantly ($P= 0.013$) longer than pre-cooling. This significant time difference might be caused by the cold induced MF and MPF decrease in sEMG. Previous studies showed that muscle fatigue resulted in electromechanical delay during cold exposure [1, 4].

Conclusion:

Moderate degree and duration of cooling may affect muscle motor unit firing rates, thus shifting the sEMG spectrum to lower frequencies, therefore decreasing the leg muscle force production. The result suggests that muscle cooling can cause cold induced frequency decrease in sEMG similar to fatigue response and lead to reduced muscle performance.

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