The Impact of Fatigue in Knee Flexor and Extensor Muscles on Proprioceptive Perception of Joint Angular Velocity

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Summary

The study investigated two distinct groups regarding proprioceptive perception of velocity in knee joint before and after the induction of mild localized fatigue. One group was assessed following fatigue induction in the knee flexors, while the other group was assessed in the knee extensors. The results indicated no statistically significant difference before and after the implementation of the fatigue protocol. It is likely that the proprioceptive system is sufficiently robust to compensate for altered proprioceptive input when a single muscle group is slightly impaired, as in the case of mild fatigue.

Introduction

Proprioception is essential for balance, joint stabilization, and injury prevention [1]. Among proprioceptors, muscle spindles are considered the most important, as their primary function is to detect stretch speed and muscle length [2]. It is assumed that fatigue may result in reduced muscle responsiveness and a diminished ability to maintain balance [3]. Several studies have shown that fatigue has deleterious effects on knee position sense, however, limited knowledge exists regarding the impact of muscle fatigue on knee angular velocity perception[1]. The purpose of this study is to investigate the effect of fatigue in knee flexors and extensors on knee angular velocity sense.

Methods

The sample consisted of a total of 46 young, healthy individuals with nonathletic physical activity levels, divided in two groups. The "knee flexors fatigue" group included 20 participants (20.55y.o., ±2.259) and the "knee extensors fatigue" group included 26 participants (21y.o., ±1.017). The assessment tool was the isokinetic dynamometer Biodex System 3pro. The assessment protocol consisted of three stages. In the first stage, the target velocity was demonstrated passively (5 times) using the isokinetic dynamometer, followed by active replication of the velocity by the participant as accurately as possible (5 times). Next, fatigue of the knee flexors or extensors muscles was induced. Finally, the same process of demonstration and replication of the target velocity was repeated. The target velocity for the "knee flexors fatigue" group was 20°/s, and for the "knee extensors fatigue" group, it was 75°/s, to be in some consistence with their faster contraction ability. The isokinetic induced fatigue was mild (at 80% of the participant's maximal peak torque), and all the participants were tested, a week prior to the assessment, to ensure their fatigue would be maintained during the time of proprioception assessment protocol.

Results and Discussion

In both groups, the average absolute error from the target velocity before and after the fatigue protocol showed no statistically significant difference.

Table 1: The average absolute error before and after the fatigue protocol for both flexors and extensors and its Standard Error.

Group		Before		After	
		Mean	Std. Error	Mean	Std. Error
Flexors	Extension	4.405	0.876	4.181	0.872
	Flexion	4.118	0.656	3.658	0.714
Extensors	Extension	11.061	1.356	8.486	1.112
	Flexion	13.338	1.787	9.295	1.451

Table 2: The difference before and after fatigue protocol did not show statistical difference.

Group		Average Absolute Error	
		Z	Asymp. Sig. (2-tailed)
Flexors Before-After	Extension	0.112	0.911
	Flexion	0.597	0.550
Extensors Before-After	Extension	-1.714	-1.740
	Flexion	0.086	0.082

The results indicated that mild localized fatigue in both the knee flexors and extensors appears to have no effect on velocity replication at low velocities. The deficit is presumably compensated by proprioceptive input from neighboring proprioceptors, allowing the brain to process the information accurately.

Conclusions

Although fatigue seems to affect position sense, the current results indicate that the proprioceptive system is robust enough to manage movement with precision, even when a muscle group is functioning below its full capacity, such as in cases of mild fatigue.

References

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