Neurofencing - Study of Physiology & Biomechanics of a fencer's movement

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Summary

Neurofencing research strives to improve fencing performance and prevent chronic injuries. It started by evaluating the benefits of warmup in competitive fencing through EMG, EEG and EKG. Multiple fencers participated in Mount Sinai IRB study (STUDY2201661) to determine benefit of 15-minute warmup. A 9.4% faster touch speed was observed in participants for a 6ft standard lunge.

Fifty USA Fencing members including men, women, Saber, Foil & Epee fencers participated in UW IRB study (STUDY00019084). A full-body retroreflective motion capture marker set captured 3D kinematics (500 lunges). Across weapons and gender, significant differences were seen in the vertical and anteroposterior components of the ground reaction force for the leading leg, as well as for sagittal plane knee kinematics. Fencing is a combat sport yet it is relatively safe. Repeated motion target hits (100 games) enabled assessment of upper limb kinematics & related stress impact.

Introduction

Fencing is a permanent fixture at the Olympics. Agile Footwork and Bladework are hallmarks of a successful fencer. Based on sword fighting, fencing demands speed, anticipation and good reflexes. Warm-ups improve performance. A typical fencing attack technique involves the lunge - explosive extension of the fencer's body propelled by the non-dominant (ND) leg in which the dominant (D) leg is kicked forward. We study the physiology, underlying kinematics, healthy range of joint motions to prevent injuries.

Methods

Six fencers, participated in Mount Sinai (STUDY2201661) over the course of two days. One day included a 15-minute warmup of predetermined exercises. All fencers performed ten lunges towards a fixed target 6ft away each day. Delsys Trigno sensors were placed on various muscle groups to collect electromyogram (EMG). Two-minute recordings of electrocardiogram (EKG) and electroencephalogram (EEG) at baseline and post-lunge timepoints was taken. EEG data w/ Neuroelectrics Enbio to assess band power across eight channels. EKG data was collected w/ Polar H10, HRVElite.

Fifty fencers participated in UW (STUDY00019084). Fencers conduct five standard lunges (SL) and five advanced lunges (AL) towards a dummy target 6ft away. These lunges were captured using VICON motion capture system w/ 60 markers on each subject. The second part of the experiment involved playing two games (G1) & (G3) on a Favero fencing target and scoring their discomfort level with nine wrist tendon injury rehabilitation exercises.

Results and Discussion

A 9.4% faster touch speed was observed after 15-minute warmup ($p=0.01^*$). There was significant reduction in the magnitude of the EMG spike in the forearm ($p<0.01^{**}$) and bicep ($p=0.02^*$) muscle groups, indicating improved coordination between the nervous system and muscles.

Biomechanics findings relate to ground reaction forces and analysis of dominant knee joint angle. During the extended lunge motion, their dominant foot lands with more force than the standard lunge in a shorter period of time. Both the hamstring and rectus femoris play critical roles in regulating the knee's flexion and extension, as the rectus femoris gets the dominant leg moving forward and the hamstring slows it down preventing knee over flexion (Figure 1)

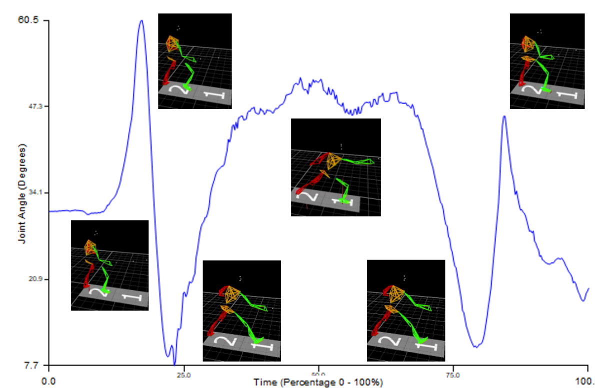

Figure 1: Sample standard fencing lunge knee flexion pattern

Conclusions

We understand fencing movements to enhance performance & prevent injuries. The rapid and repetitive fencing lunges (Take-off's & Landing) along with rapid extension and flexion produces strenuous impact loading on the lower extremities particularly the knee, hip & ankle joints which are contributing factors for knee & ankle injuries.

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References

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