SKELETAL MUSCLE STRAIN RESULTING FROM FENCING COMPETITION IN ELETE FENCERS

J.X. Li, Y. N. Guo, C. H. R. So, and H. Y. Y. Yuan
Department of Sports Science, Hong Kong Sports Institute, Shatin, N.T., Hong Kong

Information about skeletal muscle strain in fencing is limited. The objective of this study was to examine the muscle strain resulting from fencing competition by monitoring plasma creatine kinase (CK). The heart rate (HR) and blood lactate during fencing competition were examined also. Twelve national level female fencers participated in the study. The results showed that the plasma CK activity significantly increased one day after competition ($p<0.05$), which indicated high muscle strain. During the competition HR ranged from 167 to 191 bpm, the blood lactate stayed around 4 mM in most fencers. The results suggested that fencing requires a high capacity of muscle strength and speed. The enhancement of muscle strength, speed and flexibility should be paid more attention in training.

KEYWORDS: fencing, heart rate, blood lactate, muscle strain, creatine kinase.

INTRODUCTION: Fencing is regarded as a technical sport, which requires quick and accurate body movement, and good function of the cardiovascular system. Studies examining the response of cardiovascular and skeletal muscle systems to fencing are rare.

Studies on fencing have focused mainly on the biomechanical analysis of techniques, hormone responses, and the training methods for mental control. Fink (1994) studied the forces in the forward leg during a fencing lunge. The data from film and a force platform were combined to find the ground reaction forces, movements, and muscle forces in the leg. Large joint forces were found at the ankle, knee, and hip immediately upon impact. Fink's study suggested that the large magnitude of the forces requires high muscle force in fencers. Margonato et al (1994) examined the isometric force and muscle cross-sectional area of the forearm in fencers. The data from fencers were compared with the measurements in runners. Margonato et al revealed significant differences in cross sectional area and maximal force between the dominant and non-dominant forearm in fencers and runners. The fencers showed a greater cross sectional area and force in the dominant forearm compared with the runners group. These studies indicated that fencing requires high muscle strength. However, very few studies have been completed to examine the effects of fencing on muscle strain.

The sympathoadrenergic regulation in elite fencers in training and competition has been reported (Hoch, Werle, & Weicker, 1988; Markowska, Stupnicki, Golec, Nagiec, Bednarski, & Grzegorek, 1988). These studies demonstrated that the fencing training and competition caused an increase in both noradrenaline and adrenaline excretion (Markowska et al, 1988). Hoch et al (1988) found that both training and competition significantly elevated the level of norepinephrine and epinephrine all. The higher level of sympathoadrenergic hormones should cause increased heart rates. But, very few researches have described the response of the cardiovascular system in fencing training or competition.

This study examined the effects of fencing competition on muscle strain as well as cardiovascular system responses by analysing plasma CK activity one day after competition and monitoring HR as well as blood lactate during competition. The objective was to provide the information about muscle strain caused by fencing competition to coaches and sports scientists to improve fencing training and prevent muscle injury.

METHODS: Subjects: Twelve female epee fencers aged 16 to 30 years, all of them at the top national level, gave their written consent to participate in the study after detailed information. The anthropometric data and Haemoglobin (Hb) levels of the participants are presented in Table 1. The study took place in the training period before the 13th Asia Games in December, 1998. According to the medical examination, all participants were in good physical condition and fit to commence.

Table **1** Twelve Fencers with Their Anthropometric and Hb Data.

Fencer	Age (yrs)	Height (cm)	Weight (kg)	Haemoglobin (g/dl)
A	17	172	62	14.4
B	14	178	68	12.9
C	18	167	60	13.0
D	17	170	63	11.3
E	20	181	63	14.1
F	21	180	67	11.9
G	20	175	63	13.3
H	19	176	58	15.9
I	30	164	50	13.1
J	29	159	60	13.2
K	24	158	49	12.3
L	25	157	50	12.6

Procedures: The resting values of HR, blood lactate and CK were measured before the competition. Two training bouts on five hits were performed to cause a competition specific adaptation followed by a recovery 20 min. The arrangement of the opponents was organised like in competition. The HR of every fencer was monitored serially by Polar Vantage NT and Polar Sport Tester (Finland) watches during fencing competition and used as the parameter to reflect the response of cardiovascular system. The blood lactate after every bout was assayed after 1 min and 3 min to indicate the energy production. The activity of plasma CK was examined one day after the competition to indicate the muscle strain. A 1500 YSI Sport Lactate Analyser was used to analysis blood lactate. Plasma CK activity and Hb were tested using the Reflotron 4.

Data Analysis: One fencer's HR could not be recorded in the period of fencing competition. The data of HR collected from 11 fencers were analysed using the Polar HR analysis software. The highest HR, average HR and the percentage distribution of HR above 75 % maximal HR in the period of competition were calculated. The peak values of blood lactate and plasma CK activity were presented as mM and u/l respectively. A t-test was used to detect any significant difference in plasma CK activity between both of measurements before and after competition.

RESULTS: The plasma CK activity significantly elevated in most of fencers (less 200 u/l in physiological condition) one day after competition. During the competition the HR rose significantly, the average HR ranged from 165 to 191 bpm. The percentage distribution of HR at above 75 % maximal HR in the period of competition was 60 % in average. The highest value of blood lactate, 5.29 mM was detected in one fencer only, less than 4.0 mM in most fencers. The measurements of plasma CK activity and HR as well as blood lactate were presented in Table 2.

Table 2 **The Highest HR, Average HR and the Percent Distribution of HR at above 75% Maximal HR in the Period of Competition, the Peak Value of Blood Lactate, and the CK Activity for Each Fencer**

	Heart Rate			Blood Analysis	
Fencer	Highest HR (beats/min)	Average HR (beats/min)	HR up 75% max HR (%)	Peak Lactate (mM)	CK (u/l)
A	177	155	85.0	2.13	271
B	181	146	36.2	1.45	213
C	177	148	33.3	2.84	166
D	171	149	71.4	3.08	996
E	167	142	53.3	3.69	158
F	171	135	10.3	2.02	149
G	177	150	55.8	4.4	248
H	193	162	76.6	2.19	147
I	-	-	-	4.0	314
J	179	158	91.0	5.29	180
K	183	156	79.0	2.59	347
L	181	155	68.4	4.51	281
Mean	178	150	60.0	3.18	289*

*$P<0.05$, CK activity after fight vs the normal control

DISCUSSION: It is generally thought that fencing is a vigorous activity that requires high cardiovascular efficiency, flexibility and muscle strength and speed. Only a few studies, however, have been able to demonstrate the response of body to fencing.

The plasma CK activity significantly increased one day after competition. It indicated that high muscle strain was produced (Armstrong, 1990). The plasma CK activity was at a low level (less than 200u/l) in the physiological condition. Elevated CK activity can be found in conditions of alteration or damage of cell membranes. Fatiguing, uncustomary, or heavy muscle contraction can induce plasma CK activity increase (Armstrong, 1990; Clarkson, Cymes, McCarmick, Turcotte, & White, 1986). Therefore, elevated levels of blood CK has been used to estimate skeletal muscle damage and its magnitude, especially in humans (Clarkson et al. 1986), and in experimental animals (Schwane, Johnson, Vandenakker, & Armstrong, 1983). The results of CK activity determination indicated that fencing requires high muscle contractile capacity, although the maximal muscle contraction was only a short duration. Therefore the training on muscle strength and speed should be emphasised in training.

The present study showed that fencing sport produces high stress on cardiovascular system. The HR of fencers was at a high level, average 157 bpm during competition. The average HR distribution exceed 75 % of maximal HR taken account for 60 % of the period of competition. It is well established that heart rate rises linearly with increasing work load. The fencing competition in this study should be submaximal load based on the HR response. Since maximal muscle contraction in fencing appears to be of only short duration, higher HR could be due to the physical demands and the additional emotional involvement (Lehmann, Huber, Spoeri, Berg, & Keul, 1983).

The blood lactate was less than 4 mM in most fencers during competition in this study. The changes of blood lactate were consistent with the study by Hoch et al (1988) and agreed with the HR response.

CONCLUSION: This study demonstrated that fencing produces high muscle strain even in the training competition. The work load was predominantly covered by aerobic energy production. The high HR response in fencing competition indicated that fencing requires good cardiovascular function. The enhancement of muscle strength, speed and flexibility in fencers should be paid much attention in training to prevent muscle injury and improve performance.

REFERENCES:

Armstrong, R. B. (1990). Initial events in exercise-induced muscular injury. *Medicine & Science in Sports & Exercise,* **22**(4), 429- 435.

Clarkson, P. M., Cyrnes, W. C., McCarmick, K. M., Turcotte, L. P., & White, J. S. (1986). Muscle soreness and serum creatine kinase activity following isometric eccentric, and concentric exercise. *International Journal of Sports Medicine,* **7,** 152-155

Fink, P. (1994). Force in the forward leg during a fencing lunge. In: *Institute for Sport and Human Performance,* University of Oregon, Eugene, Ore,

Lejmann, M., Huber, G., Spoeri, U., Berg, A., & Keul, J. (1983). Zum Verhalten von Plasma und Harm Dopamin, Noradrenalin und Adrenalin bei kÖrperlichen und kÖrperlichen-konzentrativen Belasungen. *Herz-Kreislauf,* Baden Baden

Margonato, V., Roi, G. S., Cerizza, C., & Galdabino, G. L. (1994). Maximal isometric force and muscle cross-sectional area of the forearm in fencers. *Journal of Sports Science,* 12, 567-572.

Hoch, F., Werle, F., Weicker, H. (1988) Sympathoadrendergic regulation in elite fencers in training and competition. *International Journal of Sports Medicine,* **9**(Supp. 2) Aug. S141-S145.

Markowska, L., Stupnicki, R., Golec, L., Nagiec, E., Bednarski, J., & Grzegorek, K. (1988). *Biology of Sports (Warsaw),* **5**(2), 93-101.

Schwane, J. A., Johnson, S. R., Vandenakker, C. B., Armstrong, R. B. (1983). Delayed onset muscular soreness and plasma CK and LDH activities after downhill running. *Medicine and Science in Sports and Exercise,* 15, 51- 56.