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EFFECTS OF EXERCISE FATIGUE ON PLANTAR PRESSURE IN BADMINTON : A EXPLORATORY STUDY

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The purpose of present study was to evaluate the effect of exercise fatigue on plantar pressure in badminton. One badminton athlete volunteer without any injury or disease in the latest 3 months attended this study. Peak pressure(PP) and integration of pressure and duration(Pt) of pelma pre- and post-fatigue were measured. Results show that PP of heel was the highest. After fatigue, the PP of heel and Pt of metatarsal were increased significantly, and the Pt of heel was decreased significantly. In badminton training, it's necessary to enhance muscular strength and arrange training intensity for individual. More and deeply biomechanical research should be done to lessen pain and injury.

KEY WORDS: fatigue, badminton, injury.

INTRODUCTION: As one of the most popular sports, more and more people like to play badminton or watch the game. But study (2006) on 120 youth badminton athletes from 15 provincial representative teams and 8 university teams in China mainland showed that 79.2% athletes sustained sports injury. Epidemiologic investigation (2009) of sports injury of badminton elite indicated that waist, ankle, knee, thigh and foot were high incidence of sports injury. Fatigue have been identified as one of major task-related risk factors that have effects on gait. Some research results have also showed that decreased physical function including the weakening of muscle strength of lower limbs caused by exercised-induced fatigue could lead to variation of gait cycle and postural imbalance. There are some studies on the characteristic of plantar pressure in badminton, but little study investigate the chang of plantar pressure pre- and post-fatigue. For China badminton national team players, Wei Yong et al. (2008) found that driving-turning (one-step) take-off at left rear-count, driving-off stride at left front-court, driving-off stride at right front-court and chasse at right front-court were the four kinds of footwork with highest use frequency during matches. In this study, we supposed that fatigue will influence players plantar pressure in badminton. Here, fatigue was induced by repeating the motion of driving-off stride at right front-court and driving-off stride at left front-court.

METHODS: One healthy badminton athlete volunteer (Ht=181cm; Wt=62Kg; training year=12y) was involved in this study. He self-reported to have no injuries, illness,or musculoskeletal disorders that could affect his motion in badminton. And at the same time, he signed the informed consent form.

At the beginning of experimental sessions, the participant was instructed to driving-off stride at right and left front-court to touch the badmintons hanged over the badminton net at his self-selected comfortable speed. Then he was required to change a pair of new shoes equipped with novel insole-force-plate (Pedar-X, Novel). Fatigue exercise began when the participant was used to shoes and the special motion. During the fatigue exercise, the participant was asked to driving-off stride 30 strides as instructed (right front-court and than left) in one trail, 3 trails in total, and 15s break between two trails.

Pelma was divided into 9 masks (see Fig 1.) by Pedar-X software, peak pressure(PP) and integration of pressure and duration(Pt) were measured. RPE, rate of heart (RH) and blood lactate(BL) were used to evaluate the level of fatigue. Before trail and at the end of every trail, these index were measured as soon as possible.

Data analysis was carried out using Spss 19 software. The peak pressure and integration of pressure and duration were analyzed by One Way ANOVA. $P<0.05$ was taken an the significant level.

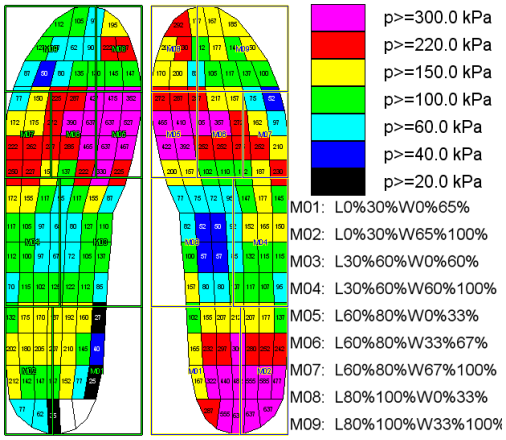

Figure 1. 9 Masks of pelma

RESULTS and DISCUSSION: Values of RPE, rate of heart and blood lactate before exercise and at the end of every trail have been shown in table 1. where 0 means before exercise. We can see that the participant was deep fatigue at the end of 3rd trail. Hence, we define the group1 as group of pre-fatigue, and the group3 as group of post-fatigue.

Table 1

RPE, rate of heart and blood lactate

group	RPE	RH (/s)	BL (mmol/L)
0	6	80	1.6
1	10	184	5.4
2	16	205	11.6
3	19	210	13.2

Table 2

Peak of pressure(PP) and integration of pressure and duration(Pt) of Total, M1, M2, M5, M6, M7 and M8. And statistical analysis of PP and Pt.

		PP (kpa)		Pt(kpas)	
mask	group	Mean	SD	Mean	SD
TOTAL	1	637.500	.0000	100.450	6.1518
	2	560.000	45.9619	109.350	6.7175
	3	467.500* #	.0000	115.700	11.1723
M1	1	633.750	5.3033	74.200	9.0510
	2	413.750*	76.0140	49.050	4.3134
	3	362.500*	31.8198	42.050* #	1.3435
M2	1	637.500	.0000	74.800	10.7480
	2	560.000	45.9619	52.450	5.0205
	3	467.500* #	.0000	44.350* #	1.9092
M5	1	271.250	33.5876	73.100	8.2024
	2	260.000	17.6777	91.950	8.9803
	3	252.500	14.1421	99.850	11.3844
M6	1	210.000	10.6066	64.200	3.9598
	2	247.500	35.3553	89.650	11.1016
	3	252.500	14.1421	98.850*	10.6773
M7	1	152.500	53.0330	39.500	.4243
	2	138.750	12.3744	48.700	4.3841

		PP (kpa)		Pt(kpas)	
mask	group	Mean	SD	Mean	SD
	3	127.500	3.5355	53.750*	5.5861
M8	1	181.250	33.5876	49.150	8.9803
	2	185.000	21.2132	59.100	4.8083
	3	183.750	22.9810	67.100	11.0309

P=0.05,*means to have significant difference with group1, # means to have significant difference with group2.

During exercise, force on the heel and metatarsal are larger than the other parts of foot, PP and Pt of total, M1, M2,M5,M6,M7,M8 of pelma were analyzed in the study. Table 2 shows value of Peak of pressure(PP) and integration of pressure and duration(Pt) . It reveals that PP of M1 and M2 decreased significantly in group3 (post-fatigue), but the data of M5, M6,M7,M8 changed little. Statistic analysis shows there is significant differences between group3 and group1 (pre-fatigue) (M1: p=0.011; M2: p=0.008). No significant differences tested for other masks. For total PP, the p=0.008. This can be explained that fatigue weakened the muscle strength of lower limbs, the touch force of foot and ground decreased. This is in accordance with some studies on effect of fatigue to gait. In the other hand, compared to pre-fatigue, table 2 shows that Pt of M1 and M2 decreased significantly(M1: p=0.012; M2: p=0.022) in post-fatigue, but the Pt of M5, M6, M7 and M8 are all increased (M5: p=0.069; M6: p=0.033; M7 p=0.04; M8: p=0.13). Although, value of p for M5 and M8 is larger than 0.05, change is also clearly.Pt is the integration of pressure and duration,it is better than PP to reveal the effect of fatigue on foot. Less energy can be used for motion and more energy were needed to make himself to keep balance when the player under fatigue. That is why the Pt value of heel decreased and the Pt value of metatarsals increased. Consequently, the metatarsals, especially the first (Pt_{M5}=99.850Kpas)and fifth metatarsal (Pt_{M7}=53.750Kpas, p=0.04) are easy to be pain or even injury in badminton athletes.
Also, we can find some significantly differences between group1 and group2, group2 and group3. According to the RPE, RH and BL, we can't classify the group2 as pre-fatigue abstractly. There's no question that after the 2nd trail, player was not lifeful anymore.

CONCLUSION: This study simple badminton sports as repeated driving-off stride at right and left front-court, and made the participant fatigue. Compared to the pre-fatigue, the PP of heel and Pt of metatarsal under post-fatigue were increased significantly, and the Pt of heel was decreased significantly. In badminton training, it's necessary to enhance muscular strength, arrange training intensity for individual. More biomechanical research should be done.

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