FACTORS AFFECTING FREE THROWING

Motoi Fukushima
Uwadaira Biomechanics Institute for Education
Kanazawa, Japan; 920

Masaru Kawaguchi
Okayama Biomechanics Institute for Education
Shiga, Japan; 523

Kimitaka Nakazawa, Yoshitsugu Mohri, Masahiro Takashima, Hiroh Yamamoto
Laboratory of Biomechanics
Faculty of Education, Kanazawa University
Kanazawa, Japan; 920

Every basketball player has an appetite to increase the free throw shooting performance. Sometimes the game depends upon their success shots. But it is difficult for basketball players to improve their own performance because, to do so, there are some factors such as good timing of muscle activity and mechanical efficiency. Especially relating to mechanical efficiency, it was investigated in various physical movements. As a result, previous study indicated that mechanical efficiency was an importnat index to "skill". However, it has not been reported about its improvement in conjunction with training. Therefore, the purpose of this study was to determine the mechanical efficiency of free throw shooting exercise in basketball, and assess the imporvement of mechanical efficiency and performance through an eight week training program.

METHOD

Nine male students (5 skilled males, members of Kanazawa University Basketball Team, Japan, and 4 unskilled males) were served as subjects. Furthermore, the unskilled males were placed into two groups (training group, N=2: control group, N=2). Table I shows physical characteristics of each subject. The subjects performed a five-minute free throw shooting exercise, which was composed of fifteen shots per minute, according to a metronome.

To determine the mechanical work, the free throw shooting motion during the last 20 seconds of the exercise was filmed by a 16mm high spped camera placed 17m from the subject with 64 fps. Mechanical work was calculated utilizing NAC motion analyzer with digitizer.

Mechanical work = $m_1 \cdot g \cdot h$ (Potential energy) + $\frac{1}{2} \cdot m_2 \cdot v^2$ (Kinetic energy) + $\frac{1}{2} \cdot I \cdot \omega^2$ (Rotational energy)

(m_1 : mass of body, g: acceleration of gravity, h: displacement of body weight, m_2 : mass of ball, v: ball velocity, I: inertia moment and ω :angular velocity)

Expired gas was collected using Douglas bag method and gas samples were analyzed using Scholander technique during last two minutes of a 5-min free throw shooting exercise. Furthermore, oxygen uptake at rest (10 minutes before exercise) was collected to calculate the net energy cost.

The mechanical work rate and corresponding net energy cost (energy cost at steady state - energy cost at rest) were determined for each subject of free throw shooting exercise. Mechanical efficiency was caluculated with the formula (Net efficency = Mechanical work / Energy cost above at rest) of Gaesser et al (1975).

Two of the unskilled male participated in the 8 weeks training program, which was composed of a 5-min free throw, shooting exercise five times per week. Work intensity was about 40.3% of VO max. They were periodically tested on the first day (Test 1), the 7th day (Test 2), the 14th day (Test 3), the 21st day (Test 4), the 42nd day (Test 5) and 56th day (Test 6).

To determine the Performance, success shots were counted during a 5-min free throw shooting exercise.

Table 1 Physical characteristics of each subject.

Subject	Age(yrs)	Height(cm)	Weight(kg)	$\dot{V}O_2$max(ml/kg·min)	Experience(yrs)
T.K.	21.9	176.0	69.0	55.88	0 unskilled
S.H.	23.4	171.0	63.0	57.10	0 unskilled
K.N.	20.5	168.0	63.0	62.50	0 unskilled
T.S.	20.5	167.0	65.0	52.61	0 unskilled
K.H.	22.3	172.0	56.0	61.64	10 skilled
E.N.	23.4	172.0	70.0	56.30	10 skilled
Y.N.	22.2	180.0	72.0	68.20	10 skilled
I.S.	22.4	177.0	69.0	64.00	10 skilled
K.Y.	20.5	164.5	58.0	-	9 skilled
Mean	21.9	171.8	65.0	59.77	-
S.D.	1.0	4.8	5.2	4.81	-

RESULTS

Mechanical efficiency of free throw shooting exercise was 18.5% for the unskilledand 13.8% for the skilled. There was no significant difference for mechanical efficiency between the unskilled and the skilled ($P>0.05$). On the other hand, free throw shooting performance was 19.5 goals for the unskilled and 47.4 goals for the skilled. Performance of the skilled was significantly higher than that of the unskilled ($P<0.01$).

Figure 1 shows the improvement of mechanical efficiency through an 8 weeks training program. As for the training group, mechanical efficiency changed from T 1;12.9, T 2; 12.5, T 3;13.7, T 4;13.3, T 5;12.9 and to T 6;14.5%. Comparing T 1 and T 6, the value of T 6 was significantly higher than that of T 1 ($P<0.05$). As for control group, mechanical efficiency changed from 13.4% (before training) to 14.2% (after training). But there was no significant difference between T 1 and T 6 ($P>0.05$).

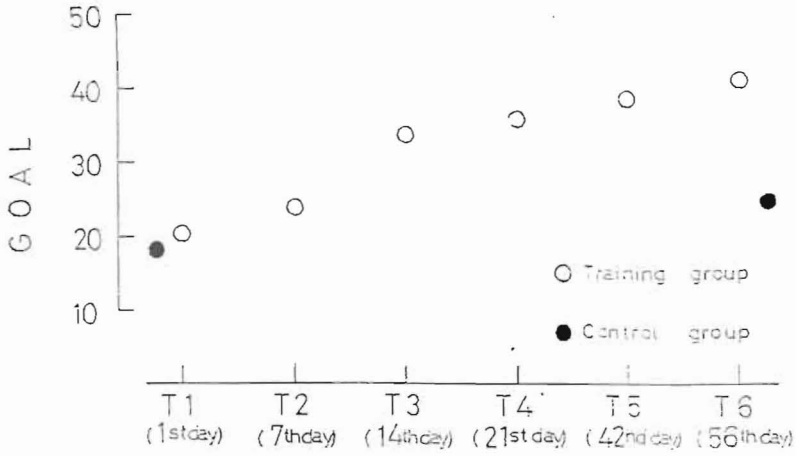

Figure 2 Changes of free-throw shooting performance in each test for training group and control group

DISCUSSION

In this study, mechanical efficiency of the free throw shooting exercise ranged from about 10% to 15%. These values are higher than those of swimming (Adrian,1966),(Miyashita,1970) and (Holmer,1972) and other type throwing such as overhand throwing in European handball (Yamamoto,1984), lower than those of walking (Asmussen and Bond-petersen,1974) and running (Lloyd and Zacks,1972) and similar to those of simple joint exercise(Cathcart et al,1924).

No difference for mechanical efficiency between the skilled and the unskilled causes that two groups performed the free throw shooting exercise at almost the same mechanical work, that is especially potential energy. This result is opposed to that of the previous study (Carry and Wishart,1934), in say, the values of the skilled was higher than those of the unskilled for mechanical efficiency.

As for the movement of the free throw shooting exercise, it is considered that subjects for the training group performed it smoothly and utilized whole body gradually through training program. Therefore, potential energy which is high proportion to total mechanical work increased according to the increment of the displacement of body weight through training. On the other hand, net energy cost did not change through training. However, the mechanical efficiency increased through training. This is why they were able to work much more through training while maintaining the same energy cost as in the beginning of the training program. Moreover, the free throw shooting performance of the subjects also increased through training. It is concluded that the improvement of mechanical efficiency might be one of the factors which influence on the increase of performance through training.