THE EFFECT OF TWO DIFFERENT WEIGHTED BADMINTON RACKETS ABOUT VELOCITY AND TORQUE WHEN OUTSTANDING BADMINTON PLAYERS WAS PERFORMING SMASH MOVEMENT

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The purpose of this research is to study and to analyze the relationship of the velocity and torque between two different weighted badminton rackets while the elite players was performing the smash movement .All the data of this study is filmed by digital video (60Hz/s) and is analyzed on the space of 2D by sagittal plane and horizontal axis movement of the participator .In order to derive from the primary parameters of smash motion, including velocity, movement of inertia, angular acceleration, torque. The data are digitized and filtered in APAS (the Ariel Performance Analyze System). As a result, by T-Test, the T-values are up to the observable level ,and the level a is 0.05.

KEY WORDS: smash, velocity, moment of inertia, angular acceleration, torque.

INTRODUCTION: Smashing is the key point to win in the badminton game. Besides the skill, the weight of the racket is the most important factor that athletes can dominate easily. A constant theory is those who want to change the state of action must overcome the inertia of racket .To gain the most advantage in the game, one must try to obtain more inertia of rotation to decrease the torque. During the past few years, the researches about this field were not treated seriously .So this study can set up the parameters of model for both teachers and coaches.

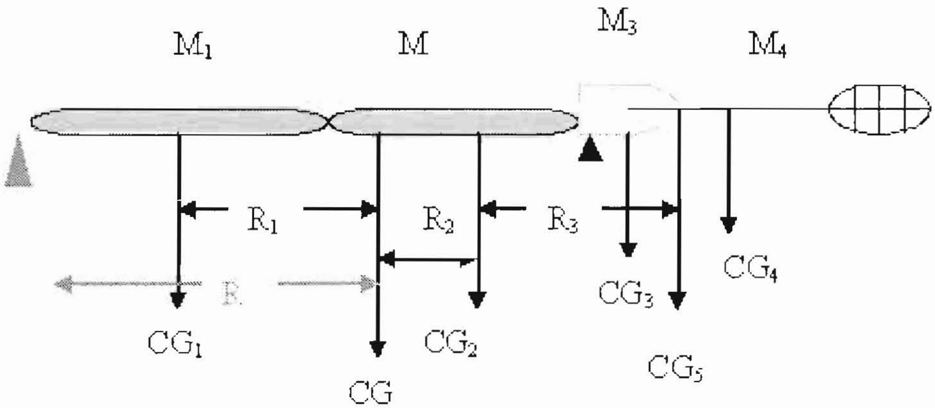
METHODS: Four outstanding female badminton players(age 20.3 ± 3.2yrs, tall163 ± 5.2cm,weight 54.8 ± 3.9kg,competiton experience10.3 ± 2.8yrs)are served the subjects for this study .They were recorded by a digital video(JVC GR-DVL9800,60Hz/s) while using two different weighted rackets to smash .Then the film was trimmed , digitized , direct linear transformed and filtered in APAS system to obtain the variables of velocity , angular acceleration .The center of mass (CM)and the weight of three-segments(upper arm ,fore arm ,hand with the racket)were evaluated ,which quote from Dempster's and Jin-cheng Wang's parameter(table 1).First , we must calculate the center of gravity between the hand and the racket according to Parallel Theory .Then we estimate the center of three-segments(including the rackets),the outcome can be the parameters of moment of inertia(formula 1,2). The variables of data shows details in figure 1.

Table 1The Data of Three-segments and Racket about Participators.

	upper-arm	fore-arm	hand+racket(85g)	hand+racket(100g)
length(cm)	30.55±2.28	23.75±1.7	66.5	66.5
weight(kg)	1.48±0.12	0.88±0.07	0.41±0.0275	0.429±0.0275
length(cm) (from segment' CM to shoulder joint)	13.75±1.0	10.85±0.75	13±0.346	13.5±0.356

Data from Dempster (1955) & Jin-Cheng Wang(1983).

Figure 1:The Method of Calculate the Position of CM about Three-Segments and Racket.



: three-segments' fulcrum. :hand+racket's fulcrum.
M1: the mass of upper arm. M2: the mass of fore arm.
M3: the mass of hand. M4: the mass of racket.
M=M1+M2+M3+M4 (the sum of three-segments and racket).

CG1: the position of CM (center of mass) about upper arm.
CG2: the position of CM about fore arm.
CG3: the position of CM about hand.
CG4: the position of CM about the racket (the point of balance).
CG5: the position of CM about hand and racket.
CG: the position of CM about the sum of segments and the racket.

r1 : distance from shoulder joint to the CM of upper arm.
r2 : distance from shoulder joint to the CM of fore arm.
r3: distance from shoulder joint to the hand and racket.

R1: length from the CM of three-segments to upper arm.
R2: length from the CM of three-segments to fore arm.
R3: length from the CM of three-segments to hand and racket.
R: length from the CM of three-segments to shoulder joint.

Parallel Theory:

$R=M_1R_1+M_2R_2+(M_3+M_4)R_3 / M$----------------formula 1

$I_0=I_g+MR^2=M_1R_1^2+M_2R_2^2+(M_3+M_4)R_3^6+MR_2$-------------formula 2

Where I_0 is the moment of inertia that is the fulcrum for shoulder joint while smashing, and I_g is the sum of moment of inertia from three-segments and racket.

RESULTS AND DISCUSSION: Table 2 shows the velocity of both different rackets. Very obviously, the velocity of heavier racket (100g) is much faster than the lighter one (85g)while smashing. And the T-values are up to apparently level by T-Test (the level is 0.05). The stability is the variable standard deviation divide into the velocity . So if concerning the stability of a smash action, a heavier racket (92%) will surely has more advantages over the other one (88.7%).

Table 2 The Testing Result of the Velocity of both different Racket.

	racket(85g)	racket(100g)	T-values
velocity(m/s)	65.99±7.48	69.42±5.49	-3.78*
stability	88.7%	92%	

*p<.05

Table 3 shows the kinetics variables of both different weighted badminton rackets during the movement of smashing .The angular velocity of weightier racket is much faster than the other one, and so is the angular acceleration. According to the formula of torque, it was equal to angular acceleration multiplied by the moment of inertia of the hand and racket (formula 3). Due to the both moment of inertia are very closely .So the heavier one can obtain faster velocity of badminton in the smash action.

Table 3 The Kinematics Variables of Badminton Smash.

	racket(85g)	racket(100g)	T-values
angular velocity(rad/s)	17±4.48	19.4±3.97	
angular acceleration(rad/s2)	1032±268.8	1164±238.2	
moment of inertia(kg·m2)	0.37±0.073	0.39±0.078	
torque(kg·m2·rad/s)	381.84±19.62	453.96±18.58	-162.09*

*p<.05

Torque(T) = Moment of Inertia(I) × angular acceleration(a)-------formula 3

CONCLUSION: This study demonstrates the biomechanical variables that can be caused by the two different weighted rackets when the elite players are smashing .The steadiness of smash movement goes up to 92% when they use the heavier racket. However, a lighter one just only reach 88.7% in the same action. As the shoulder joint be the fulcrum, the angular acceleration of smash movement was much faster while holding the heavier one. Because the variables of both moments of inertia are very close, the heavier racket can absolutely be superiority to the lighter one in torque.

REFERENCE:

Dempster, W. T. (1955). Space requirements of the seated operator .WADC Technical Report 55-159, Wright-patterson Air Force Base, Ohio, 55-195.

Wang, J. C. (1993). The estimated research of human segment in Taiwan. Achievements account of monographic study , National Science Council ,Executive Yuan, 5 , 59.