

# Kiai and Mechanical Characteristics of Some Karate Punches

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## INTRODUCTION

In the studies from the aspect of biomechanics the essential data can be found in the field of the punches - motions which are characterized as precise, fast and maximally forced.

In the study of Yoshihuku (1984) it was found that the duration of the force was concentrated between 16 and 19 ms regardless of the kind of the techniques, implying that the human body that was not rigid took the above time to transmit its momentum to the target.

In the research about the flow of the energy from trunk to arm in Tsuki movement (Yoshihuku, Ikegami, Sakurai, 1984) it is pointed out that the main source of energy in Tsuki movement is not in the upper arm itself, but in the other parts of the body. It is interesting that in each trial the first hit the target with its maximum velocity, just or nearly at the moment when both the energy flow and the kinetic energy reached their maximum velocity.

In the study about the central regulation problems of the human motion abilities in the biomechanical structures (Chaidze, 1966) it is pointed out that the reduction of the velocity in the arm extension is necessary before the collision, with purpose to fix the joints and to increase the mass included in the punch.

The value of the collision impulse depends on the movement velocity in

the moment of the collision ( $v_c$ ), and the mass of the body included in the punch (the equivalent mass -  $m$ ). Because of this and some other conditions characteristic for karate combats, these parameters should be improved during the training sessions.

It might be that Kiai is one of the factors which enables better demonstration of these values. That is why the subject of this study is Kiai, the phenomenon which is relatively unexplored up to now, or in other words, its influence on mechanical characteristics of karate punches Gyaku Tsuki and Tettsui Uchi.

The need for such of study originated from the importance which is given to Kiai in the rules of sports karate combats. It is well known that Kiai is also an unavoidable companion in Tameshi Wari breaking techniques.

The purpose of the present study is to establish possible differences between mechanical characteristics of the chosen punches.

## **METHODS AND PROCEDURES**

On the sample of fifteen randomly chosen karate masters the anthropometric variables were evaluated, according to the method I.B.P.: the height of the body, the mass of the body, the volume of the upper arm (maximal volume of the extended arm), the skin wrinkle of the upper arm, the length of the arm and the span of the arm. Devenport - Kaup's length and weight index was also calculated.

The speed of simple and complex reaction on sound signal was measured.

For the sake of data accumulation of kinematic and dynamic characteristics of punches (collision impulse, equivalent mass, maximal velocity, collision velocity, average velocity, average to maximal velocity, average after maximal velocity, average acceleration), the combination of optical-electronic cinematographic «Selspot» system and tensiometric platform «Kistler» was applied.

The results of measuring were treated by appropriate statistical procedures (basic descriptive statistical parameters were calculated and normality of distribution was tested, correlational and factor analysis were performed and Snedecor's «t» - test for small dependent samples was applied for quantitative differences).

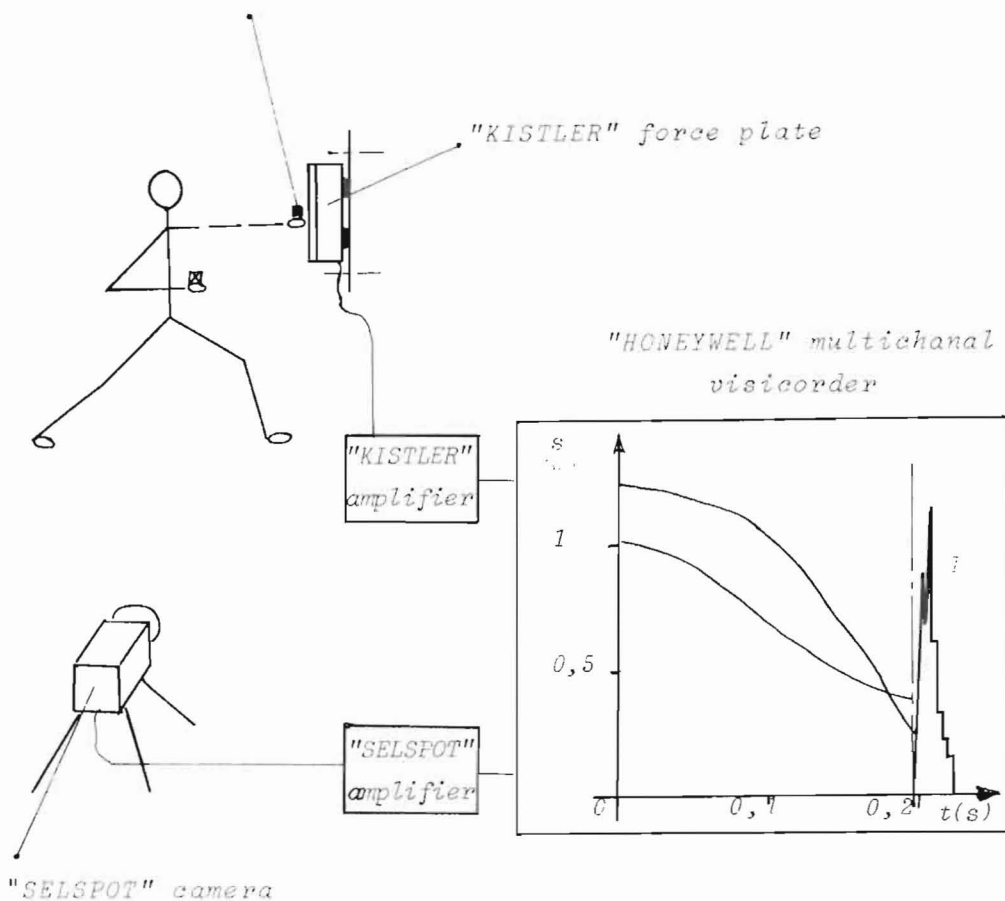


Fig. 1 Measuring of mechanical characteristics of Gyaku Tsuki punch with an example of visicorder record.

## RESULTS

The value of the collision impulse of Gyaku Tsuki punch performed with Kiai was from 21,91 to 40,70 Ns. The value of the collision impulse of Gyaku Tsuki punch performed without Kiai was from 22,60 to 35,07 Ns.

The value of the maximal velocity of Gyaku Tsuki punch performed with Kiai was from 7,30 to 10,32 m/s, and without Kiai from 7,18 to 9,62 m/s.

The value of collision velocity of Gyaku Tsuki punch performed with Kiai was from 6,33 to 8,80 m/s, and without Kiai from 5,93 to 8,30 m/s.

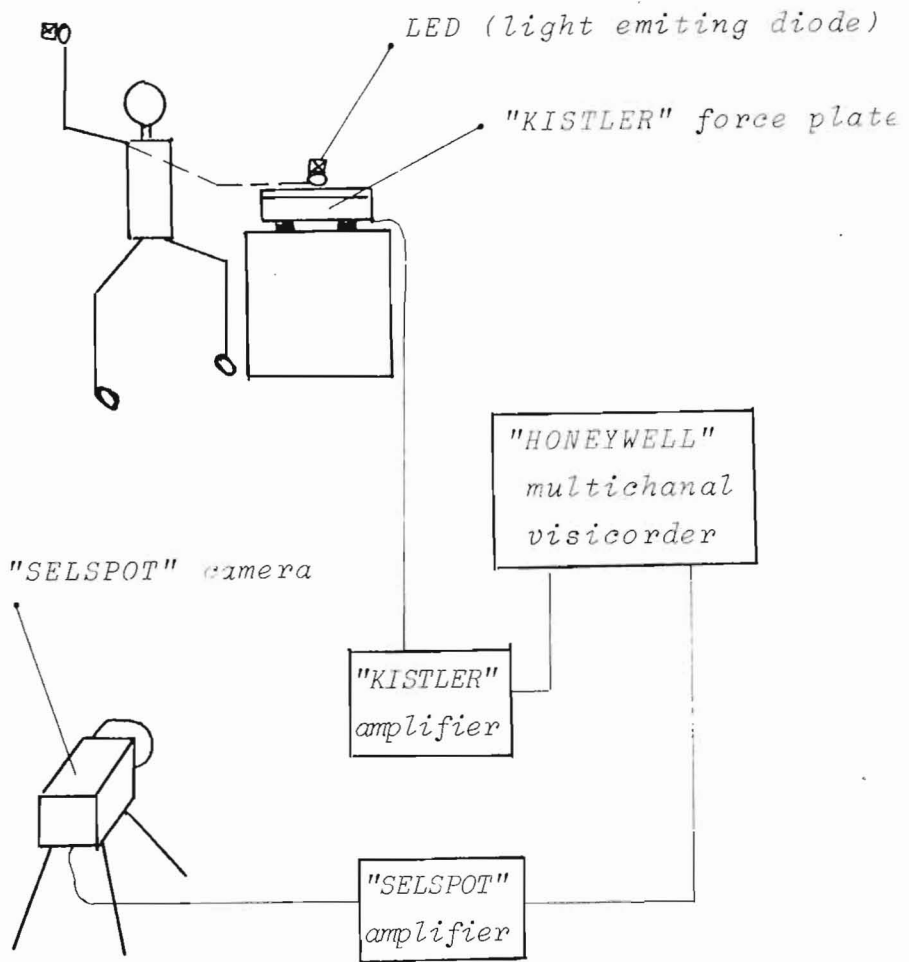


Fig. 2 Measuring of mechanical characteristics of Tettsui Uchi punch.

The value of average after maximal velocity of Gyaku Tsuki punch performed with Kiai was from 6,81 to 9,29 m/s, and without Kiai from 6,61 to 8,92 m/s.

The value of equivalent masses of Gyaku Tsuki punch performed with Kiai was from 3,28 to 4,84 kg, and without Kiai from 3,30 to 4,72 kg.

The differences of mechanical characteristics with and without Kiai are given in the table 1.

**TABLE 1**  
**GYAKU TSUKI punch - the differences of average values in depended samples**

Variables	$\bar{X}$	$\bar{X}_k$	$S_x$	$S_{x_k}$	$(\bar{X}_k - \bar{X})$	t	p=
l	28,310	29,859	3,991	4,806	1,549	1,754	0,10
em	3,962	3,953	,500	,447	-,009	-,128	0,90
$v_{max}$	8,342	8,723	,783	,955	,381	2,007	0,06
$v_{ud}$	7,167	7,551	,719	,838	,384	2,007	0,06
$v_2$	7,754	8,137	,741	,878	,383	2,052	0,06

The value of the collision impulse of Tetsui Uchi punch with Kiai was from 17,64 to 27,17 Ns. The value of the collision impulse of Tetsui Uchi punch performed without KIAI was from 13,52 to 26,75 Ns.

The value of the maximal velocity of Tetsui Uchi punch performed with Kiai was from 13,51 to 16,69 m/s, and without Kiai from 14,06 to 17,51 m/s.

The value of collision velocity of Tetsui Uchi punch performed with Kiai was from 10,37 to 14,78 m/s, and without Kiai from 11,49 to 15,76 m/s.

The value of average after maximal velocity of Tetsui UCHI punch performed with Kiai was from 12,48 to 15,44 m/s, and without Kiai from 12,48 to 15,44 m/s, and without Kiai from 12,91 to 16,63 m/s.

The value of equivalent masses of Tetsui Uchi punch performed with Kiai was from 1,27 to 1,89 kg, and without Kiai from 0,97 to 1,96 kg.

The differences of mechanical characteristics Tetsui Uchi punch performed with and without Kiai are given in the table 2.

**TABLE 2**  
**TETTSUI UCHI punch - the differences of average values in depended samples**

Variables	X	$X_k$	$S_x$	$S_{x_k}$	$(X_k - X)$	t	p=
l	19,065	20,511	3,506	2,618	1,446	2,694	0,02
em	1,413	1,549	,254	,194	,136	2,036	0,06
$v_{max}$	15,165	14,944	,952	,940	-,221	-,878	0,40
$v_{ud}$	13,519	13,302	1,073	1,228	-,217	-,607	0,55
$v_2$	14,341	14,123	,990	1,018	-,218	-,742	0,47

## DISCUSSION AND INTEPRETATION

It is possible to give a graphic representation about the moving of collision surface of fist on the basis of obtained data about the velocities.

The values of the velocities in this research highly agreed with the results of Nakayama and Kato's studies realized on Tokushoku University in Tokyo.

Actual curve (which presents the movement velocity - picture 3), or in other words, the decrease of the velocity value in the second phase agrees with Chaidze's statements (1966).

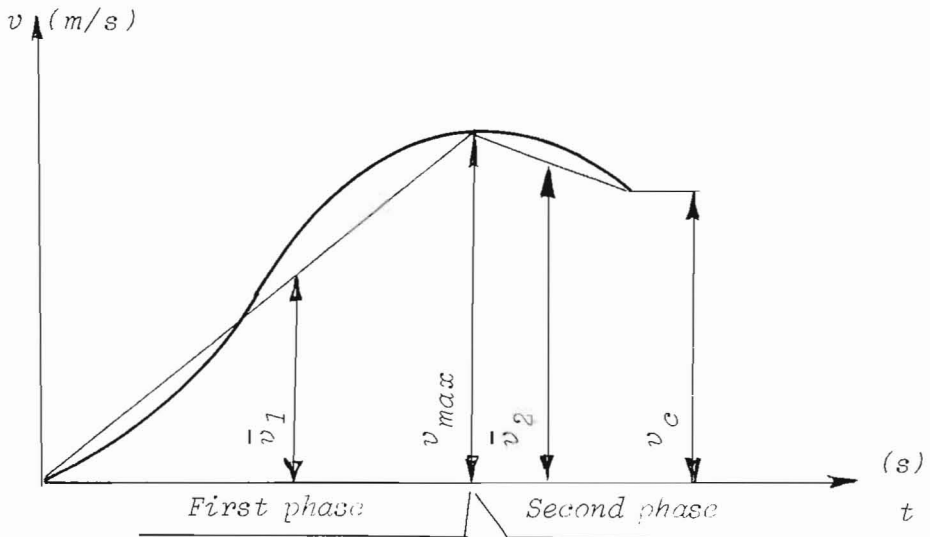


Fig. 3. The moving of velocity of collision surface of fist during the time.

By long-range training of Kime (jap. - focus, the maximal will contraction of the whole muscular system of the body in as short time as possible), and by training with equipments (boxing-bags, makivaras), it is possible to develop fine and conscious feeling of pushing - «the continuity of moving» in the moment of collision, and form the system of solid lever arm of the punching extremity.

This is one of the possible explanations of the results which obtained Yoshihuku, Ikegami and Sakurai in their research where the fist punched the target with its maximal speed.

Between the values presented in the table 1 (Gyaku Tsuki punch) these values are distinguished: maximal speed, collision speed and average speed after maximal, with the level of importance  $p = 0,06$ . This indicates the quantitative difference in kinematics of the second phase of Gyaku Tsuki punch performed with Kiai.

The differences of the collision impulse of Tettsui Uchi punch performed with and without Kiai are on the level of importance of  $p = 0,02$ , while the differences of equivalent masses are on the level of importance of  $p = 0,06$ . This indicates that the quantitative difference exists in mechanical efficiency of Tettsui Uchi punch when performed with Kiai.

## CONCLUSION

It can be concluded that the obtained significance level of differences indicates the influence of Kiai on mechanical characteristics of karate punches. It is possible that bigger sample would cause the higher level of statistical importance.

## REFERENCES

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