BIOMECHANICAL TRAITS ANALYSIS WHEN PERFORMING OF JUDO UCHIMATA BY POSTURE AND VOLUNTARY RESISTANCE LEVELS OF UKE

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The purpose of this study was to analyze the biomechanical traits variables when performing *uchimata* (inner thigh reaping throw) by voluntary resistance levels (VRL) and two postures of *uke* (defender, receiver) in Judo. The postures of *uke* were *shizenhontai* (straight natural posture:NP) and *jigohontai* (straight defensive posture:DP), VRL of *uke* were 0% and 100%, respectively. The biomechanical variables were temporal (total time-required: TR), postures and COG during performing *uchimata*. It's important for judoists to prepare for individual analysis, prescription and countermeasures because they have experienced several variables when performing techniques according to opponent's postures and VRL in biomechanical aspects.

KEY WORDS: *judo-uchimata* (inner thigh reaping throw), *tori* (attacker) and *uke* (defender, receiver), *shisei* (posture), center of gravity (COG), voluntary resistance levels (VRL) 0% and 100%, *shizenhontai* (straight natural posture:NP), *jigohontai* (straight defensive posture:DP), biomechanics

INTRODUCTION: *Judo* has developed into a modern Olympic sports and the main elements of competition are the physical fitness, technique, and fighting spirit. *Judo* is composed of basic movements : *rei* (etiquette), *shisei* (posture), *kumikata* (engagement positioning), *shintai* (advanced and retreat), *taisabaki* (body shifting, body control), *kuzushi* (balance-breaking), *tsukuri* (positioning, set-up), *kake* (application, execution), *ukemi* (breakfall) etc. in technical aspect. *Ukemi* is the basic technique on practical judo among them (Kodokan,1994). Basic movements of *judo* are various essential movements, behaviors, and forms of conduct that form the foundation of *judo* training. These include fundamental points of etiquette, a variety of postures and stances, ways to advance, engage, retreat and shift the body, as well as various ways to set up and apply techniques. In order to improve the performance in *judo*, it is necessary for *judoists*, to have a hard training by analyzing and evaluating the performance factors influencing the performance competence and by controlling the quality and quantity of the training. Besides, it can be said to be important to find out and synthesize the structures and relationship of the performance factors, and apply them to the performance in real competitions (Kim,1996; 1997;2003;2004; Kim, Yoon and Kim,2004). The factors influencing the performance in all sports can be classified into internal and external ones. These factors are composed of the primary ones, which the players should perform themselves, and the secondary ones, which are not directly related with the players themselves.
Ashi-waza (foot and leg techniques) is a very important skill in *judo*, as analysis of technical frequency in inter'l and nat'l *judo* tournaments, the frequency of *uchimata* (inner thigh reaping throw) was more than other skill, especially a lot of *judoists*' favorite skill is *uchimata* (Kim and Kwon,2003).
The purpose of this study was to analyze the biomechanical traits variables when performing *uchimata* by voluntary resistance levels (VRL) and two postures of *uke* (defender, receiver) in *judo*.

METHODS: The subjects, were one male *judoist* (YH) for 1992 Barcelona Olympic Games (silver medalist), and one male trainee; Y.I. University representative member (SDK) and were filmed executing *uchimata* as like in real competition by two S-VHS 16 mm video cameras (60 fields/sec.) through 3-dimensional motion analysis methods that postures of *uke* were *shizenhontai* (NP) and *jigohontai* (DP) and VRL of *uke* were 0% and 100%, respectively.

The biomechanical variables were temporal (total time-required:TR), postures of attacking knee, distance of cog, distance of resultant cog between *uke* and *tori* (the thrower), velocity and acceleration of cog when performing *uchimata*.

Analysis Methods: The data of this study were digitized by SIMI Motion Programs. The mean values and the standard deviation calculated for each variables.

RESULTS: When performing *uchimata* according to each posture and VRL of *uke*, and results are shown in Figure1, posture variables Figure 2 ~ 5. cog variables Figure 6 ~ 8., and velocity of cog Table 1.
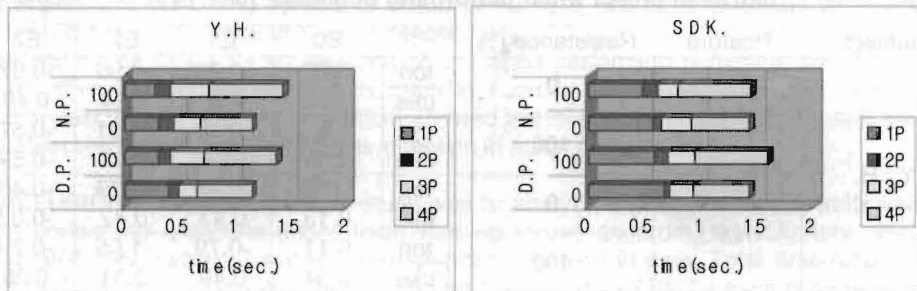

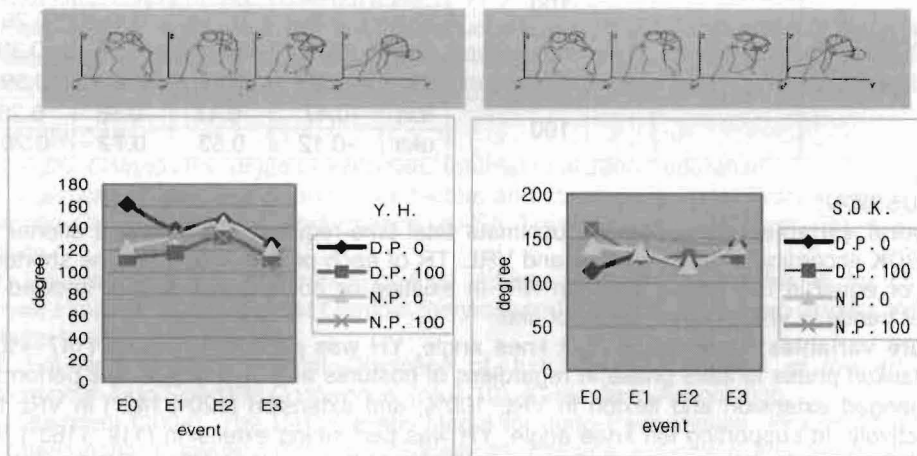**Figure1 Time-required (TR) each phase when performing *uchimata*.**

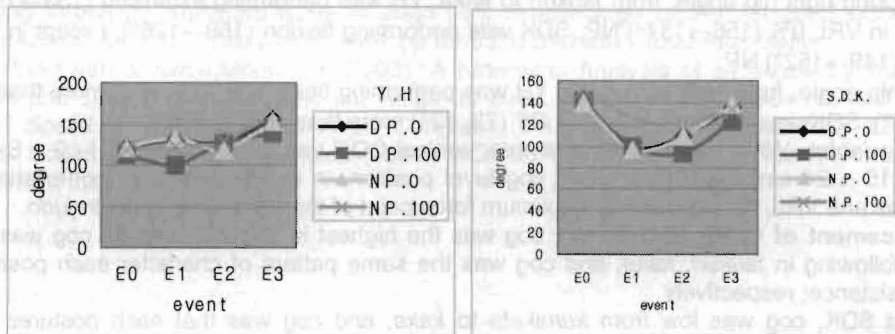**Figure 2 In attacking right knee angle each phase when performing *uchimata*.**

Figure 3 In supporting left knee angle each phase when performing *uchimata*.

Figure 4 In attacking right hip angle each phase when performing *uchimata* (omitted).
Figure 5 In left hip angle each phase when performing *uchimata* (omitted).
Figure 6 Distance of cog between *tori* and *uke* each phase when performing *uchimata* (omitted).
Figure 7 Distance of resultant cog between *tori* and *uke* each phase when performing *uchimata* (omitted).
Figure 8 Displacement of cog by ant-post. direction between *tori* and *uke* when performing *uchimata* each phase (omitted).

Table 1 Velocity of cog by ant-post. direction between *tori* and *uke* each phase when performing *uchimata* (unit: m/s).

Subject	Posture	Resistance (%)		E0	E1	E2	E3
Y. H.	D.P.	0	tori	0.22	-0.74	-0.96	-0.62
			uke	0.08	0.55	0.54	0.48
		100	tori	0.02	-0.99	-1.31	-0.57
			uke	-0.17	0.20	0.44	-0.59
	N.P.	0	tori	0.13	-0.47	-0.79	-0.46
			uke	0.13	0.43	0.42	-0.02
		100	tori	0.11	-0.79	-1.05	-0.29
			uke	0.04	0.49	0.31	0.08
S.D.K.	D.P.	0	tori	0.41	-0.66	-0.65	-0.26
			uke	-0.02	0.63	0.74	0.21
		100	tori	0.32	-0.46	-0.60	-0.38
			uke	-0.06	0.75	0.65	0.26
	N.P.	0	tori	0.30	-0.77	-0.66	-0.33
			uke	-0.03	0.61	0.61	0.39
		100	tori	0.47	-0.47	-0.55	-0.26
			uke	-0.12	0.53	0.72	0.25

DISCUSSION:

Temporal variables: In performing uchimata total time-required (TR) showed shorter YH than SDK according to each posture and VRL. TR of each posture displayed the shortened trend or equal in DP with lower than NP. In existing or not–existing of VRL showed the shorter trends in VRL 0% than 100% of uke.

Posture variables; In attacking right knee angle, YH was performing flexion (147→103°) from *tsukuri* phase to *kake* phase in regardless of postures and VRLs, SDK was performing not-changed extension and flexion in VRL 100%, and extension (120→142°) in VRL 0%, respectively. In supporting left knee angle, YH was performing extension (119→163°) from *tsukuri* (set-up) to *kake* (execution) in regardless of postures and VRLs, SDK extension (93→139°), respectively.

In attacking right hip angle, from *tsukuri* to *kake*, YH was performing extension (133→169°), except in VRL 0% (156→137°) NP, SDK was performing flexion (159→126°), except in VRL 100% (149→152°) NP.

In left hip angle, from *tsukuri* to *kake*, YH was performing flexion NP (70, 50°) more than DP (27, 57°), SDK was performing flexion DP (73, 52°) more than NP (34, 20°).

COG variables: When performing *uchimata*, vertical COG variables showed YH (:2 ~ 8 cm), SDK (:15 ~ 24 cm) lower than *uke*'s cog level position, in existing and / or not-existing of postures and VRL, during *kake* as maximum force point of throwing techniques in *judo*.

Displacement of COG: Subject YH, cog was the highest in *kuzushi*, vertical cog was low when following in *tsukuri*, *kake*, and cog was the same pattern of character each postures and resistance, respectively.

Subject SDK, cog was low from *kumikata* to *kake*, and cog was that each postures and resistance were same patterns, respectively. Subject YH, SDK, each individual, postures and resistance, vertical COG was the lowest in *kake* phase, when performing.

Distance of cog between uke and tori: It's distance when performing, subject YH was 0.64 ~ 0.70 cm in *kumikata*, 0.19 ~ 0.28 cm in *kake*, and SDK was 0.68 ~ 0.72 cm in *kumikata*, 0.30 ~ 0.42 cm in *kake*. SDK was wider than YH.

Distance of resultant cog between uke and tori: It's distance when performing, subject YH was 0.27 ~ 0.73 cm from *kumikata* to *kake*. and SDK was 0.14 ~ 0.34 cm in *kumikata*, 0.28 ~ 0.65 cm in *kake*. *Jigohontai* (YH:0.43 ~ 0.73 cm, SDK:0.59 ~ 0.65 cm) was more moved than *shizenhontai* (YH:0.27 ~ 0.53 cm, SDK: 0.28 ~ 0.34 cm).

Velocity of COG: It's velocity when performing *uchimata*, subject YH was fast anterior-posterior direction in *tsukuri*, ant.-post. and vertical direction fast in *tsukuri* and *kake*. SDK was lateral, ant.-post. and vertical direction in *kuzushi*, ant.-post. and vertical direction in *tsukuri* and ant.-post. direction in *kake*, respectively.

Acceleration of COG: It's acceleration of cog when performing *uchimata*, and the trend of subject YH showed fast vertical direction in *kuzushi* and *tsukuri*, ant.-post. and vertical direction fast in *kake*. The trends of SDK showed lateral direction in *kuzushi*, lateral and ant.-post. direction in *tsukuri* and ant.-post. direction in *kake*, respectively.

CONCLUSION The purpose of this study was to analyze the biomechanical traits variables when performing *uchimata* (inner thigh reaping throw) according to voluntary resistance levels (VRL) and two postures of *uke* (defender, receiver) in judo. Total time-required (TR) when performing *uchimata* showed the shorter time YH than SDK by each posture and VRL. Posture variables, cog variables, displacement of cog, distance of cog between *uke* and *tori*, distance of resultant cog between *uke* and *tori*, velocity of cog, and acceleration of cog showed each characteristic, respectively.

It's important for *judoists* to prepare for individual analysis, prescription and countermeasures because they have experienced several variables when performing technique according to partner's (opponent's) postures and voluntary resistance levels in biomechanical aspects.

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