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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 Figure 1, posture variables Figure 2 – 5, cog variables Figure 6 – 8, and velocity of cog Table 1.

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**Figure 1** 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).

<table>
<thead>
<tr>
<th>Subject</th>
<th>Posture</th>
<th>Resistance (%)</th>
<th>E0</th>
<th>E1</th>
<th>E2</th>
<th>E3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y. H.</td>
<td>D.P.</td>
<td>0</td>
<td>tori</td>
<td>0.22</td>
<td>-0.74</td>
<td>-0.96</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100</td>
<td>tori</td>
<td>0.08</td>
<td>0.55</td>
<td>0.54</td>
</tr>
<tr>
<td></td>
<td>N.P.</td>
<td>0</td>
<td>tori</td>
<td>-0.17</td>
<td>0.20</td>
<td>0.44</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100</td>
<td>tori</td>
<td>0.13</td>
<td>0.43</td>
<td>0.42</td>
</tr>
<tr>
<td>S.D.K.</td>
<td>D.P.</td>
<td>0</td>
<td>tori</td>
<td>0.41</td>
<td>-0.86</td>
<td>-0.65</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100</td>
<td>tori</td>
<td>0.32</td>
<td>-0.46</td>
<td>-0.60</td>
</tr>
<tr>
<td></td>
<td>N.P.</td>
<td>0</td>
<td>tori</td>
<td>-0.06</td>
<td>0.75</td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100</td>
<td>tori</td>
<td>0.30</td>
<td>-0.77</td>
<td>-0.66</td>
</tr>
</tbody>
</table>

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°-4103°) 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°-4163°) 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°-157°) 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°, 32°) more than NP (34°, 20°).

COG variables: When performing uchimata, vertical COG variables showed YH (2.2 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. Jighontai (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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