

FEAR-INDUCED CHANGES IN BREAKFALL KINEMATICS FOR OSOTO-GARI IN NOVICE JUDOKAS

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Awareness of the risk and incidence of injury during the breakfall movement may lead to a perceived fear, which could be detrimental to breakfall kinematics and may even increase the risk of judo-related head injuries. Therefore, our aim was to investigate the association between the perceived fear of the breakfall movement and breakfall kinematics for osoto-gari in novice judokas. Eight experienced and 10 novice judokas volunteered to participate in this study. Motion data of the breakfall for osoto-gari was collected using a three-dimensional motion analysis technique. We found a similar trend in the joint angle curve and peak neck extension momentum for novice judokas who perceived fear of the breakfall and for those who did not. The results indicate that perceived fear of the breakfall movement may not be associated with a novice judoka's breakfall motion skill for osoto-gari.

KEY WORDS: martial arts, head injury, motion analysis, fear of injury

INTRODUCTION: Current evidence indicates that severe and even life-threatening injuries, such as acute subdural hematoma, predominantly occur among young and inexperienced judo practitioners, which accounts for approximately 90% of all severe cases (Kamitani et al, 2013). Furthermore, being thrown backward with osoto-gari by an opponent (Figure 1) causes the majority of judo-related head injuries. Therefore, judo experts and medical professionals have agreed that avoiding direct head contact with the mat is crucial during breakfall against osoto-gari to decrease the risk of head injury, particularly among young and inexperienced practitioners.

A previous study suggests that compared to other techniques, breakfall for osoto-gari may be a more physically and mentally demanding task. Koshida et al. (2014) reported that breakfall kinematics for osoto-gari significantly differed between experienced and novice judokas; however, this difference was not observed for breakfall kinematics for ouchi-gari, another technique for throwing an opponent backward. The recent study by Koshida et al. (2015) also demonstrated that even some adolescent judokas who have years of judo experience exhibited similar breakfall kinematics for osoto-gari as novice adult judokas, suggesting that it is difficult even for judokas with experience to master proper breakfall skill for osoto-gari.

The difficulty of the breakfall and the perceived risk of injury may lead to a judoka perceiving fear of being injured, which may be detrimental to learning the breakfall skill. However, the association between perceived fear and breakfall kinematics has not been adequately studied. Therefore, the aim of this study was to investigate this association in novice judokas.



Figure 1: Breakfall for osoto-gari:

METHODS: Eight experienced male judokas and 10 novice male judokas volunteered to participate in the study. At the time of enrollment, each experienced judoka had at least 7 years of competitive judo experience, whereas each novice judoka had not previously participated in judo competitions, but had attended a minimum of 10 sessions of a judo course offered by the Ryotokuji University, Japan. The median (range) age, height, weight, and judo experience of the experienced judokas were as follows: 20 (19–21 years); 1.67 (1.59–1.84 m); 67.8 (58.9–93.2 kg); and 11.1 ± 4.0 years, respectively, whereas median (range) age, height, and weight of the novice judokas were 21 (20–22 years); 1.68 (1.63–1.81 m); and 71.8 (62.4–82.2 kg), respectively. We obtained written informed consent for all the judokas participation. The study protocol was approved by the Ethics Committee of the Faculty of Health Science, Ryotokuji University.

Prior to taking measurements, we attached 41 reflective markers (diameter, 1.9 cm and 1.3 cm for the right hand segment) on the body landmarks on the participants as previously described (Koshida et al, 2015). The participants were instructed to wear judo clothes designed to improve the visibility of the attached markers and protective headgear to ensure safety during the measurement.

The test protocol included three sets of backward breakfall performed in response to osoto-gari throws by one tester (the thrower); a 3rd-degree-black belt judoka with over 20 years' experience. As the thrower had a left-handed style, the left lower extremity of the participants was always swept first from the osoto-gari move. Subsequently, all participants were asked to gauge their perceived fear of injury and were evaluated using a 5-rank Likert scale (from "no fear felt at all" to "substantive fear felt"). All but one experienced participant answered either "no fear felt at all" or "not much fear felt." Four novice participants who answered "felt fear" were assigned to the Novice-F group, whereas four novice participants who answered "not much fear felt" were assigned to the Novice-NF group. The experienced participant who answered "felt some fear" and two novice participants who answered "neither" were eliminated from further analysis.

Three-dimensional marker trajectory data (500 Hz) was obtained using the 18-camera Mac3D motion analysis system (Motion Analysis Corp., Santa Rosa, CA, USA). The marker trajectory data was then low-pass filtered through a Butterworth digital filter at a 6-Hz cut-off frequency. Neck, trunk, right/left hip, and right/left knee joint angles in the sagittal plane were calculated, as previously defined by Koshida et al (2015). The breakfall movement was analyzed from the time when the thrower's leg first touched the participant to the time when the participant's head was at the lowest position in the vertical axis. The kinematic data was then normalized to a 100% mark.

In addition, the peak neck angular momentum in the sagittal plane was also calculated to evaluate the stress applied to the neck-head segments. Most head injuries occurred by being thrown during judo when the occipital area of the head makes a direct, hard contact with the judo mat. Our previous finding also demonstrated that the magnitude of peak neck extension momentum was able to distinguish between the high and low skill of the breakfall, indicating the value allows a prediction of the risk of head injury when being thrown with osoto-gari. The neck extension momentum was defined as the sum of the angular momentum around the virtual neck joint and the angular momentum around the centre of the head in this study. All statistical analyses were performed with Microsoft Excel 2010 and R. The Kruskal–Wallis test was performed to compare the peak neck extension momentum during the backward breakfall movement among the three groups. Statistical significance was set at $P < 0.05$. We also analyzed the averaged angle–curve data in a semi-qualitative manner.

RESULTS: The mean angle curves of the neck, hip, and knee flexion during the backward breakfall movement in the three groups are shown in Figure 2. Qualitative observations of the angle–time curves showed that the mean left hip angles started flexing at approximately the time when 20% of the phase and kept increasing the flexion angles from about 60° to 80° in the both the Novice-F and Novice-NF groups, whereas the hip angles remained slightly flexed or neutral position until approximately 50% of the phase in the experienced judokas.

Figure 3 shows the averaged peak neck extension momentum in the sagittal plane. The Kruskal–Wallis test with multiple comparison demonstrated significant differences in peak head momentum in the sagittal plane between the experienced and Novice-NF groups ($P = 0.04$). In addition, the values were different between the experienced and Novice-F groups ($P = 0.08$), but not between the Novice-F and Novice-NF groups ($P = 0.98$).

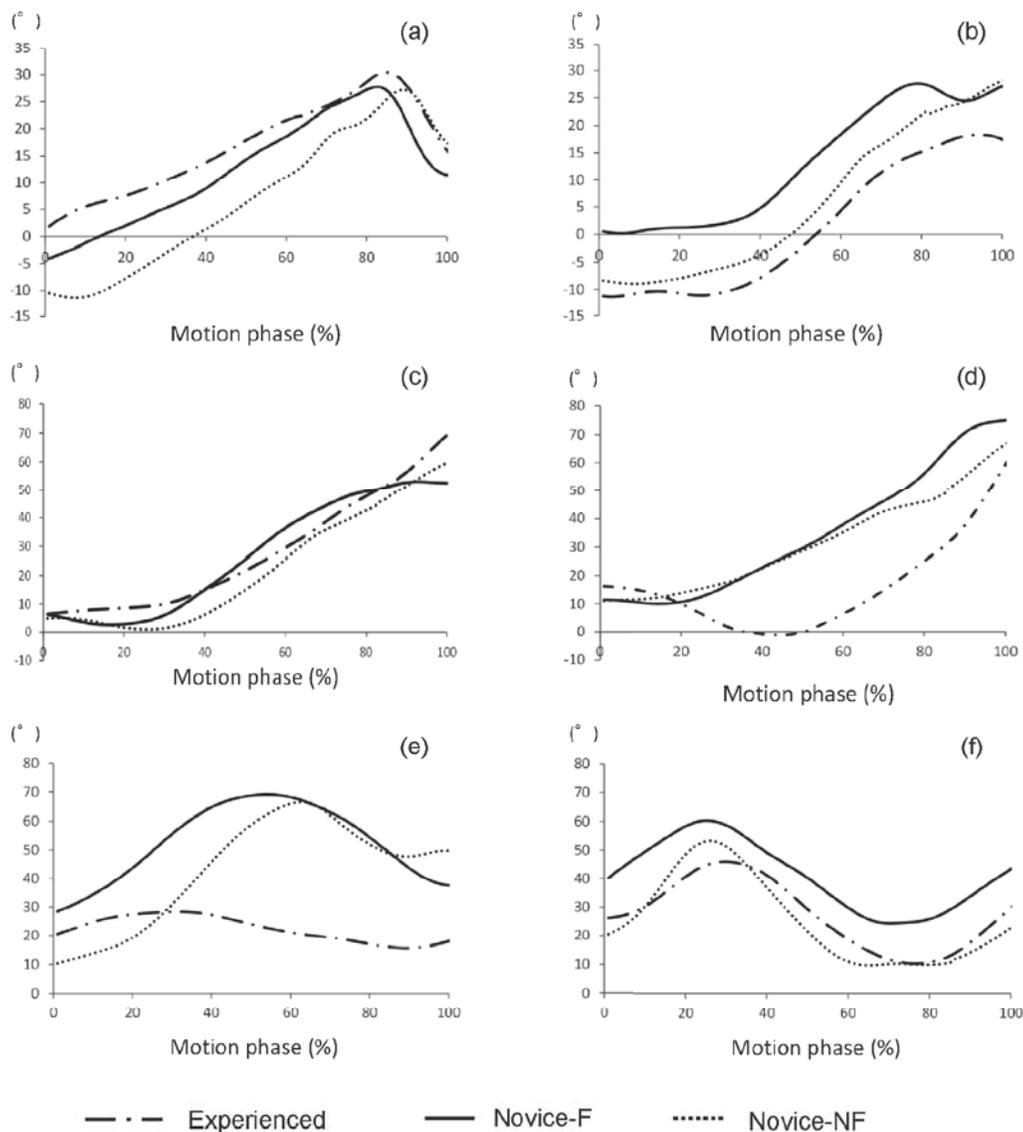


Figure 2: Sagittal plane angle–time curves in the neck(a),trunk(b),the right (c), and left (d) hip and the right (e) and left (f) knee in the experienced judokas (N = 7), the novice judokas with fear of the motion (Novice-F, N = 4), and the novice judokas without fear of the motion (Novice-NF, N = 4). Positive values represent flexion movements in all the figures.

DISCUSSION: The results demonstrated that the perceived fear of the breakfall motion was not associated with differences in breakfall kinematics in novice judokas. Based on the visual observation of the joint angle curve, the difference of the angle-change pattern was relatively small between the two novice groups when compared to the difference seen between the novice and experienced judokas. Previous studies have indicated that perceived fear of injury or anxiety can cause changes to a movement during an athletic performance (Pijpers et al, 2005); however, our results do not show a similar association. In addition, greater neck extension momentum, one of the most relevant parameters in evaluating the risk of injury,

was found between the novice judokas and the experienced judokas, but not between the two groups of the novice judokas. The results indicate that perceived fear of injury may not be associated with either breakfall kinematics or the increased risk of injury with osoto-gari in novice judokas. This suggests that the learner's perception of fear should not be relied on when teaching the breakfall movement.

The repeat findings of our previous study—change in the angle pattern of the left hip and right knee movement in novice judokas—shows that it is a robust kinematic characteristic, which may be similar to “squat protective mechanism” that is observed during backward falls in the elderly. In the instruction of how to do judo breakfall, neck and trunk flexion movements have attracted attention, e.g., “keep eyes on the tie of the belt while performing breakfall.”

The current results suggest emphasis on the movement of the lower extremities is also required to effectively teach the breakfall movement.

There are several limitations in this study that provide direction for future research. First, increased sample size would decrease the effects of individual variation on the result of study. In addition, the perceived fear of the breakfall movement was evaluated with a simple 5-rank Likert scale questionnaire. It has been suggested that anxiety can increase when performance is being evaluated, and that high anxiety and arousal in people in the early stage of learning may contribute to an increase in internal focus, which interferes with movement production. In the present study, we only focused on the perceived fear in the breakfall movement for osoto-gari; however, any increase in anxiety and arousal occurring during the measurement may have affected the result of kinematics. Using a more comprehensive psychological inventory for evaluating the anxiety status of the participants in future studies may provide us with more insight into the fear-kinematics association in the breakfall movement for osoto-gari.

CONCLUSION: We did not find any differences in the angle-time pattern and peak head angular momentum between novice judokas groups; however, this was observed between the experienced and novice judokas, suggesting that the perceived fear of the movement may not be associated with the breakfall kinematics and possible risk of injury in novice judokas.

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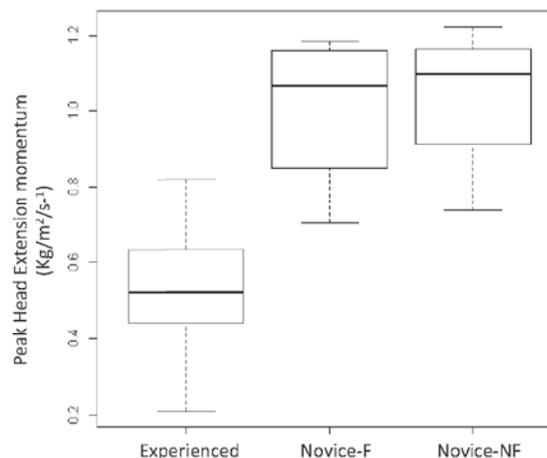


Figure 3: The peak momentum of the neck extension in the experienced judokas (N = 7), the novice judokas with fear of the motion (Novice-F, N = 4), and the novice judokas without fear of the motion (Novice-NF, N = 4).