BIOMECHANICAL STUDY OF SEOI-NAGE IN JUDO

- INFLUENCE OF ELBOW'S PAIN ON MOTION -

Yukinori Yamamoto[1], Norihisa Fujii[2] and Sekiya Koike[2]

Graduate School of Comprehensive Human Sciences, University of Tsukuba, Tsukuba, Japan [1]
Faculty of Health and Sport Sciences, University of Tsukuba, Tsukuba, Japan [2]

The aim of this study is to clarify Seoi-nage technique for reducing injuries in elbow joints. Uchikomi and Nagekomi were used as the trials. Two judo athletes with pain in elbow and three athletes without pain in elbow were instructed to perform the Seoi-nage as Tori. Strain gauge sensors were set in a judo cloth to measure the force applied by Tsurite (hand grasping the Eri). The results were observed as the follows: i) The athletes without pain applied a large force towards the throwing direction by the internal-rotation of shoulder. ii) In athlete with pain, the force direction was not towards throwing direction, but towards the left rotating side. The group without pain had an ideal movement of applying Seoi-nage. On the other hand, the group with pain did not apply kuzushi, but generate force to throw the Uke by putting flexing the trunk with external-rotation position of the shoulder.

KEYWORDS: Seoi-nage, Sensor Judogi, Elbow Injury.

INTRODUCTION: Since judo is one of the contact sports, many injuries are occurring during trainings and competitions. Therefore, there are many Judoka (Judo athlete) suffering from injuries. Some Judoka has to retire and/or change their special techniques due to their severe injuries. In Judo, the injuries in the knee joint, the ankle joint, the shoulder joint, the lumbar region, and the elbow joint are thought as the representative injuries. It is difficult for Judoka to prevent their leg joint injury due to accidents during trainings and competitions. On the other hand, it is thought that injuries in the elbow joint and the lumbar region are heavily affected by over-use syndrome. It is difficult to reduce the load on lumbar due to the rotation of the trunk and the weight of the opponent, which are the competitive characteristics of Judo. On the other hand, the technical factors such as different Judo grasp position are related to injuries, it seems that elbow joint can be prevented from injuries if the player applies the techniques appropriately. There are many researches relevant to the performance enhancement of Judo, and the researches of Seoi-nage were studied as well (Koshida et al., 2010; Ishii et al., 2016, 2017). It is reported (Onidani et al., 2017) that the elbow joint is easy to get injured in the Tsurite, hand grasping the Eri. Moreover the injuries of elbow joints frequently occur during Seoi-nage (shoulder throwing) (Kamitani et al., 2017). However, the relationships between the technique of Seoi-nage and elbow joint injuries are still unclear. The purpose of the study was to clarify the correct teaching method of Seoi-nage for reducing the elbow joint injuries.

METHODS: Uchikomi and Nagekomi, practice skills for Seoi-nage, were used in the experimental trials. Five male college Judoka (Height: 169.2±5.5cm, Mass: 74.2±7.9kg, Age: 21.8±3.3y) volunteered as participants, one as the Uke (receiver) and the others five as Tori (Thrower). Two of Tori have pain in the elbow and the other three do not have pain. One top Judoka without pain, got World champion. Participants were instructed to perform two practice skill of Seoi-nage, Uchikomi (Not throw) and the Nagekomi (Throw). Figure 1A shows the instrumented Judogi. Two strain gauge sensors (sampling rate, 150Hz) were set at collar above and below the grip. Figure 1B shows the method of Sensor Judo Cloth calibration (0.14V=2kg). Ninety-four and two reflective markers were attached to the participants and the sensors, respectively. Three-dimensional coordinate data of the makers were obtained by a motion capture system (VICON-MX, Vicon Motion Systems, 14 cameras, 250Hz). The phase of analysis was from the moment that Tori starts to apply the Seoi-nage to the moment of

completion of lifting the Uke. The local coordinate system of Tsurite was constructed with the maker coordinates of the sensor in order to distribute the Tsurite forces to each axis.

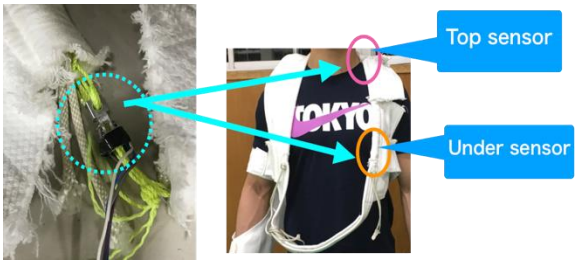

Fig. 1A. Sensor Judo cloth.

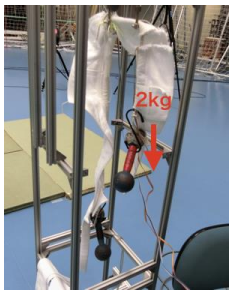

Fig. 1B. Sensor Judo cloth Calibration.

Figure 2 shows the definition of motion phases in Nagekomi. The motion phases were defined and as Kuzushi (0~40%), Tsukuri (40~70%) and Kake (70~100%), and data were normalized. The Kuzushi phase was from the tori stepped out the foot to start rotation of the body. The Tsukuri phase was until the moment that the Tori's two feet contacted the floor. The Kake phase was until the moment that the Uke was lifted from the floor. Figure 3 shows the definition of motion phases in Uchikomi. In Uchikomi, Tori repeated Uchikomi two times, and lifted the Uke at the last phase. The motion phases were defined as the first Uchikomi (0~35%), second Uchikomi (35%~70%), and lifting up (75~100%) phases.

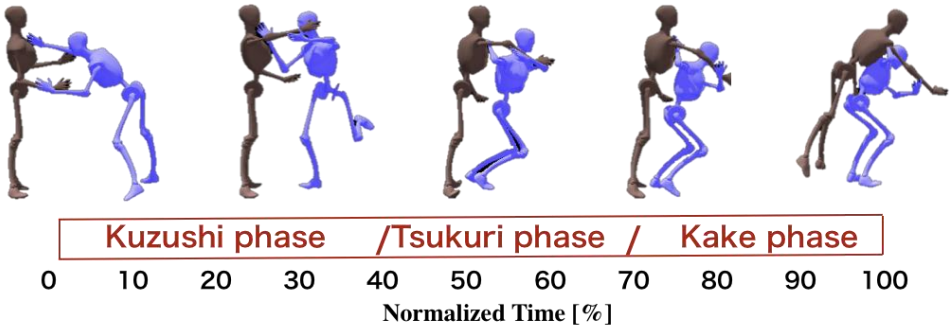

Fig. 2. Definition of motion phases in Nagekomi.

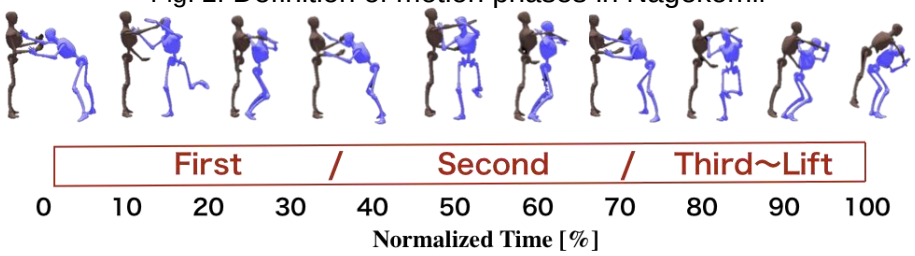

Fig. 3. Definition of motion phases in Uchikomi.

RESULTS: Figure 4 and 5 show the forces measured by the strain gauges. Figure 4 show the Tsurite force of Tori in Nagekomi. Figure 4-A shows the forces exerted by a top athlete without pain. During late Kuzushi phase and early Tsukuri phase, large forces were exerted along the Y axis and Z axes. After the Tsukuri phase the forces became small. Figure 4-B shows the forces exerted by the athletes without pain in the elbow. The forces were smaller than those of the top athlete without pain, and similar after the Kuzushi phase. Figure 4-C shows the forces exerted by the athletes with pain in elbow. At the beginning of Kuzushi phase, the small forces were exerted along the Y and Z axes. After Tsukuri phase, a large force was exerted along the X axis.

Figure 5 show the Tsurite force of Tori in Uchikomi. Figure 5-A and -B show the forces exerted by top athlete without pain and the athletes without pain respectively. Before lifting up Uke, the force patterns had similar timing to Nagekomi in top athlete and the athletes without pain, while

the magnitudes of forces were different. Figure 5-C shows the forces exerted by the athletes with pain in elbow. The timing of forces was different between Uchikomi and Nakekomi, and the large forces were exerted along the X axis.

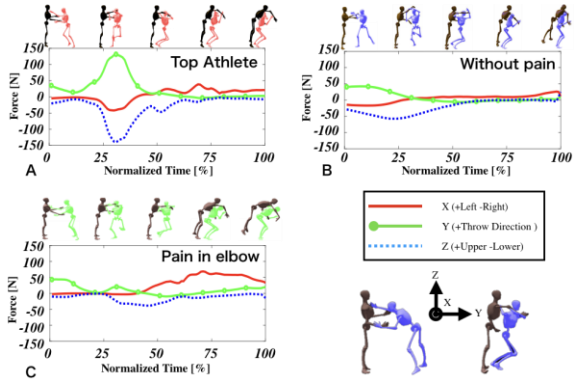

Fig. 4. The mean Tsurite force of Tori (Nagekomi).

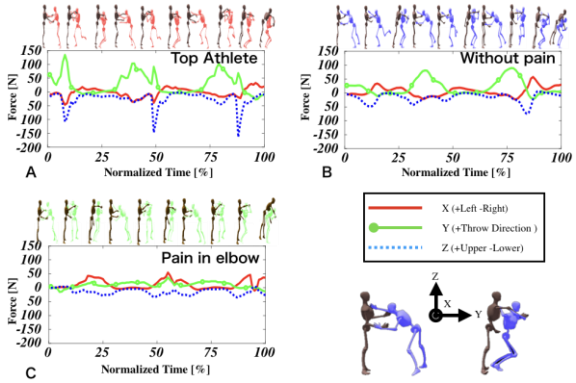

Fig. 5. The mean Tsurite force of Tori (Uchikomi).

Figure 6 show the internal-external rotation angle of shoulder joint of Tori in Nagekomi. Figure 6-A shows the internal-external rotation angle of shoulder joint of top athlete without pain. During Kuzushi phase, top athlete without pain maintained the shoulder at internal-rotation position and rotated externally during Tsukuri phase. The same external-rotation position was observed while lifting the Uke during the Kake phase. Figure 6-B shows the internal-external rotation angle of shoulder joint of the athletes without pain in elbow. During the Tsukuri phase, the external rotational angle became larger than in the Kuzushi phase. During late Kake phase, the shoulder internal rotated rapidly from external-rotation position. Figure 6-C shows the internal-external rotation angle of shoulder joint of the athletes with pain in elbow. The shoulder was in external-rotation position and became larger in Tsukuri phase. During Kake phase, the shoulder rotated internally and then rotated externally over 70 degree when lifting up the Uke.

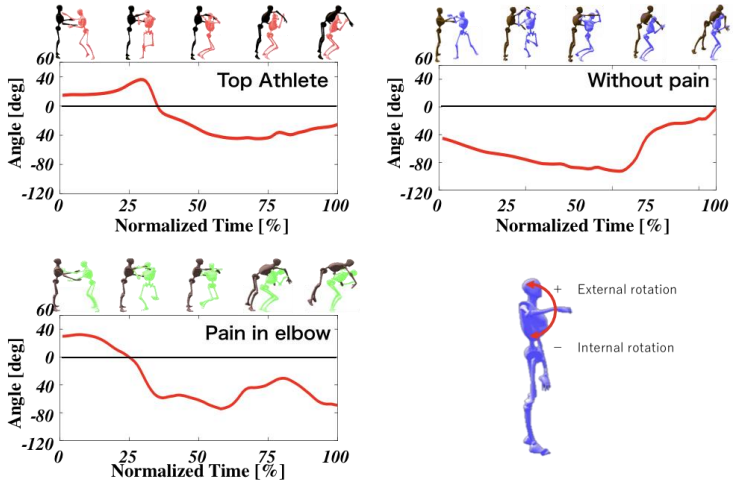

Fig. 6. The mean Internal and external rotation angle of shoulder joint of Tori (Nagekomi).

Figure 7 show the backward-forward lean angle of trunk of the Tori in Nagekomi. Figure 7-A shows the backward-forward lean angle of trunk of top athlete without pain. Top athlete without pain flexed the trunk at the beginning of the motion, and extend the trunk during the late Kuzushi phase. The forward lean angle became small during the Tsukuri phase. However, the lean angle was maintained while Kake phase. Figure 7-B shows the backward-forward lean angle of trunk of the athlete without pain elbow. The athlete without pain extended trunk during Kuzushi and Kake phases. Figure 7-C shows the backward-forward lean angle of trunk of athlete with pain in elbow. The athletes with pain flexed trunk during Kuzushi phase and flexed the trunk again during Kake phase after extending the trunk during Tsukuri phase.

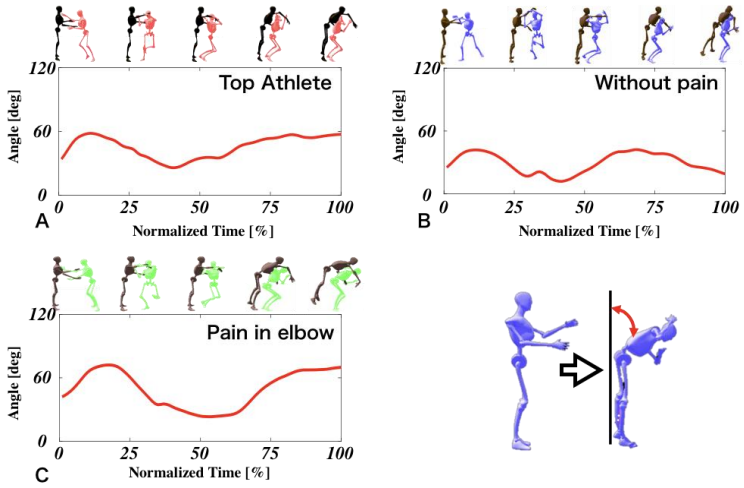

Fig. 7. The mean Backward-forward lean angle of trunk of the Tori (Nagekomi).

DISCUSSION: The aim of this study is to clarify Seoi-nage technique reducing the injuries in elbow joints. From the results of the force, it was considered that it was important to pull the Uke in order to make the space between Uke and Tori during the kuzushi phase. The athletes with pain exerted the force toward the rotating direction which implies that the movements of exerting the force and breaking down the Uke's balance. From the results of shoulder rotation angle, the Tsurite of the athletes with pain moved later rather than moved at same time with body rotation and flexion. It emptied that the Tsurite get more load due to the large external-rotation position of the shoulder. The backward-forward lean angle indicated that the flexion angle of the trunk of the athletes with pain became larger when lifting up the Uke. It was hard to maintain the posture so that the athlete with pain used too much force of upper extremity for lifting up the Uke, which may be one of the reasons why elbow of Tsurite received much load compared to the athletes without pain.

CONCLUSION: In this research, the athletes without pain applied force toward the throwing direction and internal rotated the shoulder for performing the technique, which suggested that those who play judo should pull opponent towards the throwing direction by the internal rotation of the shoulder. However, the athletes with pain applied the force along the rotating direction and performed the technique at shoulder external rotation position, which caused the much load of the elbow. It is necessary to reduce the occurrence of the injuries in coaching the basic way of applying the technique and the sequence of coaching. The way of applying the technique changes due to the characters of Tori's body, which should be considered individually in order to reduce the injuries.

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