BIOMECHANICAL FEATURES OF STRIKING MOVEMENTS ON JAPANESE DRUM <CASE STUDY>

Masae Yamazaki[1], Takahiko Satoh[1], Manabu Yamada[1], Soh-ich Shimizu[1], Tetsuaki Shima[1] , Kimitaka Nakazawa[2] and Hiroh Yamamoto[1]

[1]Biomechanics Lab., Fac. of Educ., Kanazawa University, Japan
[2]National Rehabilitation Center for Persons with Disabilities, Japan

The purpose of this study is to clarify the biomechanical features of the human striking movements observed while playing the Japanese drum by three dimensional analysis. Three subjects participated in this study in order to deterimine the motion of a professional player, an experienced player and a novice player. Digital videography method was applied to each subject, regarding their maximum effort during a 15-second exercise, and measured EMG and GRF. The results showed that the biomechanical features of striking movements are to make the most of ability with the features of Taiko, through repetition of efficient strike and recovery. Moreover, the crucial point was expressed at a strike velocity of 4.42m/s and at a recovery velocity of 3.76m/s. In addition, the feature of Yoko-uchi by a professional player is a single leg striking method.

KEY WORDS: Japanese drum, skill, effective, strike, recovery.

INTRODUCTION: This study is of the biomechanical experimental research based on art and science. Since ancient times, the drums have been one of the most common percussion instruments in the world. In previous studies there were a series of experiments in “theory of sound”, and “acoustical investigation” which studied some Japanese musical instruments. However, there has been little or no study of the human body concerning the playing motion on the drum. The charm of the Japanese drum is that of the loud sound, the player presents a dynamic motion, and while playing selects either the right or left hand in a creative melodic bond. It is of great importance to analyze the kinematics and kinetic motion with biomechanical techniques in order to improve the player’s skill. Analysis of the effective playing motion contributes to the acquisition of the skill of the novice Japanese drum players and the improvement of the skill of the experienced Japanese drum player. The purpose of this study is to clarify the biomechanical features of the human striking movements observed while playing the Japanese drum by three dimensional analysis.

Photo 1 Yoko-uchi by a professional player in KODO.

METHODS: Three subjects, a professional player (A), an experienced one (B) and a novice one(c), participated in this study. Following a warm-up, the subjects attempted four trial procedures. The task had 2 points: the first was to make the dynamic strike as wide as possible; the second was to be as fast as possible during a 15-second exercise while achieving maximum effort. A motion analysis of the Japanese drum playing exercise by the

DLT was applied to each subject. In experiment 1 the instrument used was Okedoudaiko which is 1.00m in diameter, and the sticks used were 3.5cm in diameter, 48cm in length and 264g in weight. Playing style was Shoumen-uchi. The motion was analyzed at 60Hz by four digital video cameras. The three-dimensional motion analysis system (Flame-DIASⅡ for Windows, DKH) was used to digitize the twenty three anatomical landmarks of the body and the tip of sticks. The-test was used to compare the difference of mean values; the level of significance was set at 1%. Experiment 2 was to confirm the data by measuring the kinetic features of the striking movements by EMG and GRF. The instruments used were Okedoudaiko and Nagadoudaiko which is 52.8cm in diameter. The sticks used were the standard size for each striking method. Playing style was Shoumen-uchi, Hira-uchi and Yoko-uchi. All drumming data were recorded at 60Hz with seven video cameras (Nac V-133) positioned at sagittal plantes based on VICON workstation (Oxford). EMG data was sampled with the rate of 1200 and recorded DELSYS system (WEB-500). GRF data was sampled at 1200 Hz on the force plate (Kistler). (Note: (A) is a female player who has a career of 30 years. (B) is a female who has a career of 15 years. (C) is a male and it was his first time.)

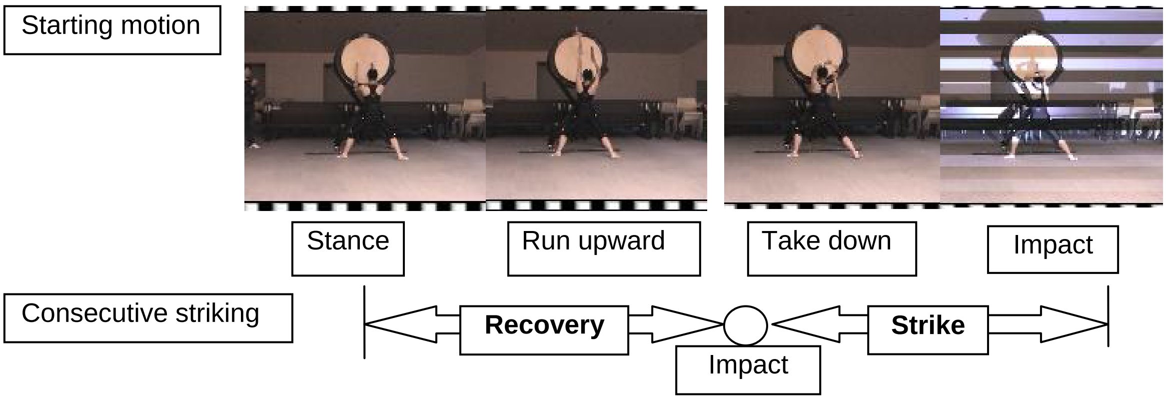
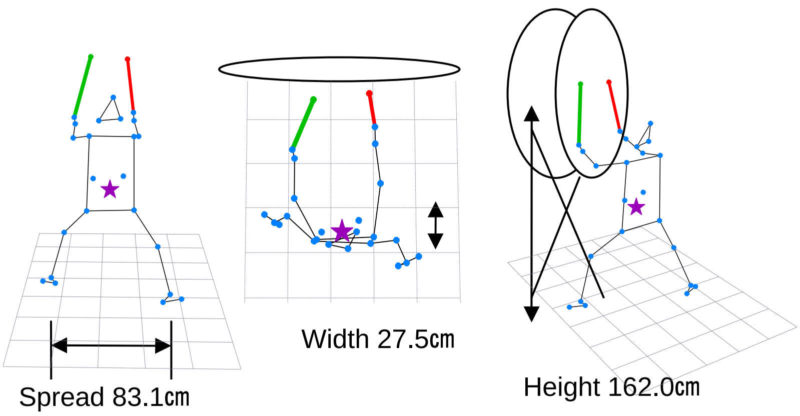


Figure 1: Definition of kinematic parameters

RESULTS AND DISCUSSION:



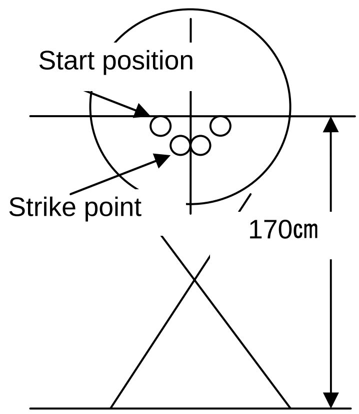


Figure 2: Stick figure silhouette before starting strikes

Figure 3: Strike position

In Experiment 1 the subject was (B). This experiment shows the particular findings to manifest three points. The first point is the posture. Fig. 2 shows that the strike motion by this subject was a dynamic motion in which she lowered her center of gravity, spread her feet wide and put her left foot back and her right foot forth. The second shows the striking position in Fig. 3. The mean of the strike position was calculated during a 15-second period. The striking point of this subject is similar to the optimal striking point as determined by coupled vibration researched in the acoustical investigations on the sound and vibration of drum. In regard to the third, the most interesting point is the striking motion. Fig. 4 shows the movements of the arm during the first a 4-second period.

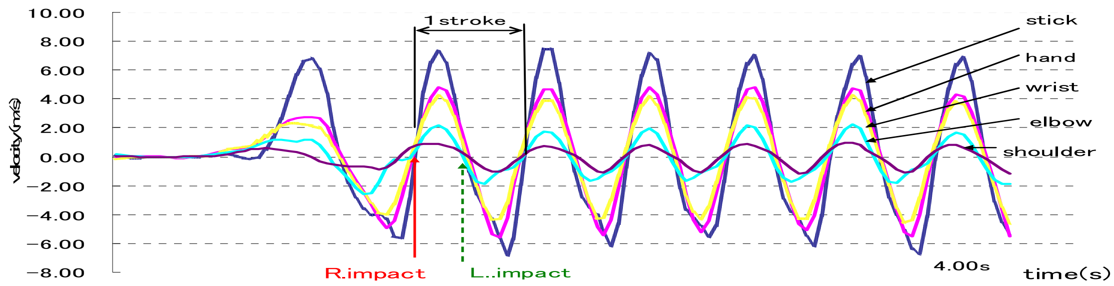


Figure 4: Variations in velocity of the stick and arm during a 4-second period

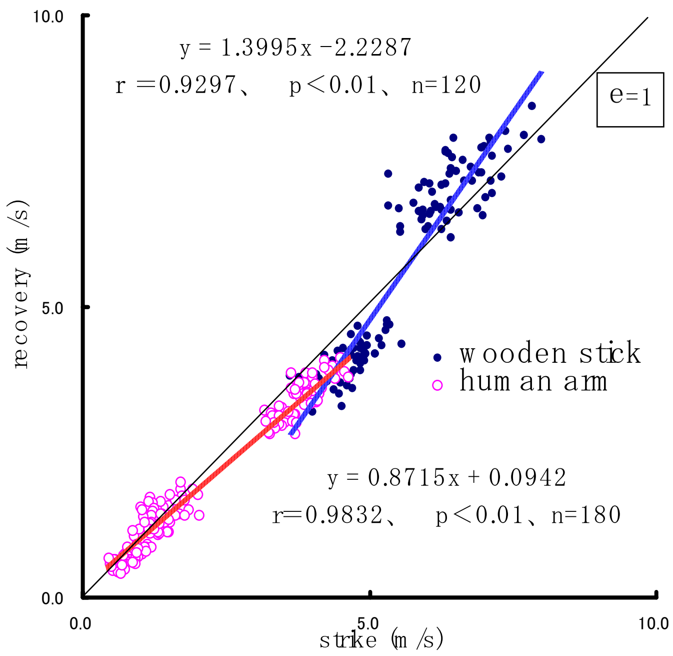


Figure 5: Relationship between recovery and strike

Fig. 5 shows the relationship of speed between the recovery phase and the strike phase. The arrow indicates the crucial point between the human arm (shoulder, elbow and wrist) and wooden stick. It is suggested that the kinematic features of the effective drumming method involves an up-swing to the high position, a snapping of the wrist, a whip-like motion of the arm, and repetition of the efficient recovery and strike motion. These steps use the bounce of KOMEN (drum skin) on consecutive strikes. The perfect bounce line (e=1) is drawn in Fig. 5. In particular there is a significant correlation between recovery(y) and strike(x) on each point of arm and stick, in the case of stick, y=1.3995x-2.2287, n=120, r=0.9297, in the case of arm, y=0.8715x+0.0942, n=180, r=0.9832 (p<0.01). Moreover, the crucial point is expressed at 4.42m/s at velocity of strike and at 3.76m/s at velocity of recovery. In Experiment 2 the subjects were (A) and (C). This experiment shows that no difference was found between the arms' movement on EMG by three playing style. The result shows the professional player used the left leg, while the novice used the right leg. Chiefly, the significant differences in kinetic features is seen LBF (left biceps femoris) by Yoko-uchi in Fig. 6. Fig. 7 shows GRF by Yoko-uchi. No vertical movement of GRF (the z-asix) by the professional player is found in each playing style in comparison with the novice one. The feature of Yoko-uchi by the professional player is a single leg striking method.

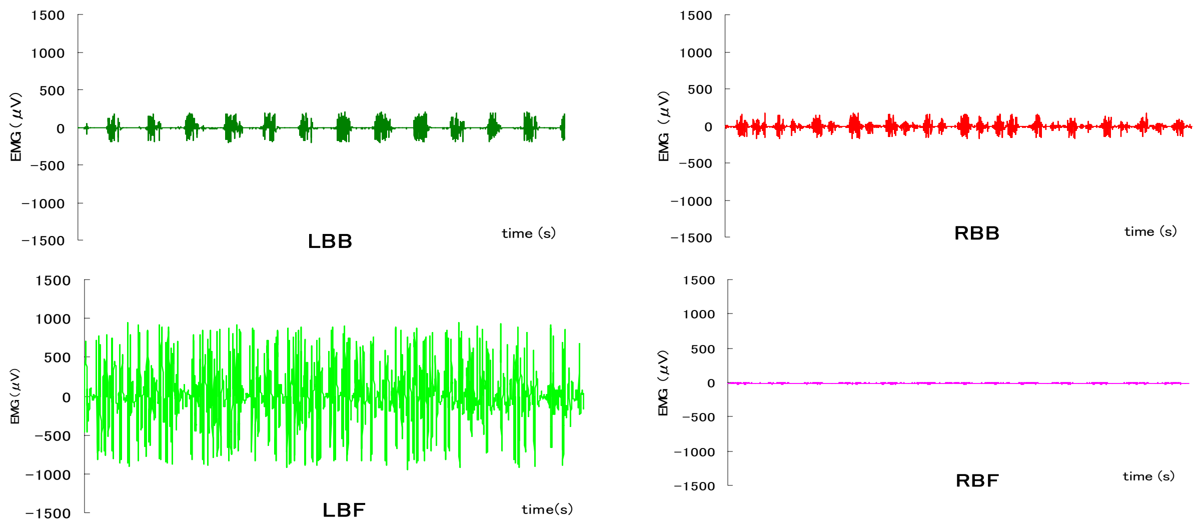


Figure 6: EMG by a professional playe

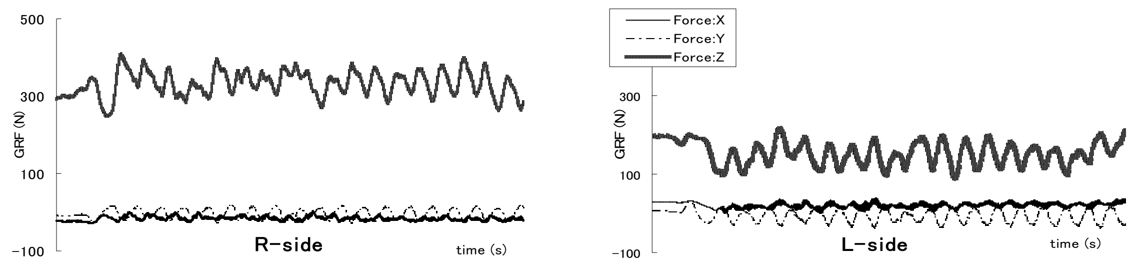


Figure 7: GRF by a professional player

CONCLUSION: It is clear that the biomechanical features of striking movements on the Japanese drum are to make the most of ability with the features of Taiko through, repetition of efficient strike and recovery. It is suggested that human striking movements are similar to the hitting movements and the pitching motion of baseball when drumming in the relaxed grip.

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