

## MOVEMENT STRUCTURES OF ROUND KICKS IN KARATE

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The purpose of this study was to identify similarities and differences of various round kicking techniques in karate in terms of kinematic characteristics. On the basis of the ankle velocity-time-courses of the supporting leg and the kicking leg, the possibility of an objective phase structuring should be proven. The subject matters are the Mawashi-Geri and the Ura-Mawashi-Geri in their various executions. In relation to the temporal structures of the movements, general and individual distinctions were found. A characteristic of Mawashi-Geri (front leg) is the appearance of two maximum values of the ankle (kicking leg) velocity. But the relation between them is dependent on the subject. For all subjects the shortest movement times were found for the Mawashi-Geri with front leg.

**KEY WORDS:** karate kick, kinematic analysis, movement structure.

### INTRODUCTION:

Mawashi-Geri and Ura-Mawashi-Geri are essential leg techniques in kumite-karate and they are often used in competition because of their high point quantitation. The purpose of the training is to optimise technique in order to achieve a high level of performance. To do this, biomechanical analyses are necessary which give information about the movement structure in general and specifics of the single technique execution and styles. Actual descriptions of kicking techniques in karate exist almost solely in verbal form (Wichmann, 1988 und Lind, 1999). To describe a movement by biomechanical parameters or curves and to compare the results between single subjects a movements phase structuring has proved oneself. Especially on the basis of velocity-time-courses movement phases can be separated (Witte, 1993 and Blaser et al., 1998). Because the focus of this pilot study was the movement of the ending link of the kinematic chain, a phase structuring on the foundation of ankle velocity-time-courses was done. This research is expected to answer the following questions:

- Are there differences with regard to temporal structure between the various types of Mawashi-Geri and Ura-Mawashi-Geri?
- How are individual variations of the round kicks characterised?

Figures 1 – 3 show the techniques of the Mawashi-Geri with front leg (fig. 1), the Mawashi-Geri with back leg (fig. 2) and the Ura-Mawashi-Geri with front leg (fig. 3).



Figure 1: Mawashi-Geri with front leg (source: <http://www.karate-dkv.de/mawashi.pdf>)



Figure 2: Mawashi-Geri with back leg (source: <http://www.karate-dkv.de/mawashi.pdf>)



Figure 3: Ura-Mawashi-Geri with front leg (source: <http://www.karate-dkv.de/uramawashi.pdf>)

## METHOD:

Three skilled male krateka participated in this study: Subject I: 4<sup>th</sup> Kyu, subject II: 3<sup>rd</sup> Dan, subject III: 2<sup>nd</sup> Dan. The following types of round kicks were analysed:

- Mawashi-Geri with front leg, Chudan (jap.) - chest area and Jodan (jap.) - face area: MflCh and MflJ,
- Mawashi-Geri with back leg (Chudan and Jodan): MblCh and MblJ,
- Ura-Mawashi-Geri with front leg (Jodan): Ufl
- Ura-Mawashi-Geri with back leg (Jodan): Ubl.

Each type of kick was performed for six trials. The break between each series amounted to three minutes. The movements were recorded by a VICON system (8 MX 40 cameras, 250 Hz). Particularly the time courses of the trajectory velocities of both ankles were analysed by Polygon and Bodybilder<sup>TM</sup>. The focus of this research was on the movement in the interval from the beginning of the turn / adduction of the supporting leg to the end of the snapping phase (pointing at the target). The back motion into a balanced stance was not considered.

To find out general and individual characteristics for all subjects and each performed technique the ankle velocity-time-courses were represented. The qualitative analysis of these curves serves to identify similarities and differences. For a quantitative analysis the phases were separated and the following parameters calculated: total time of the movement and phase time of kicking. By means of the Mann-Whitney-U-Test the differences between the mean values of the time parameters were verified.

## RESULTS:

**Movement phase structuring:** Figures 4 a) - c) show the average velocity-time-courses of the ankles of the supporting leg and the kicking leg. The time points represent characteristic points in the movement for which a phase separation can be identified:  $t_1$  - beginning of the turn / adduction of the supporting leg,  $t_2$  - lift of the kicking leg,  $t_3$  - beginning of the snapping phase of the thigh,  $t_4$  - pointing at the target,  $t_5$  - end of the movement, taking a balanced stance. Some movement phases can be defined by means of these time points:

- Preparatory or introductory phase by supporting leg: from  $t_1$  to  $t'_1$
- Start up phase of the thigh of the kicking leg: from  $t_2$  to  $t_3$
- Snapping phase of the lower leg: from  $t_3$  to  $t_4$
- Returning to a balanced stance: from  $t_4$  to  $t_5$

In addition, an overlapping phase  $t_{ov}$  can be determined, in which the turn or the adduction of the supporting leg is not finished before the lifting of the kicking leg begins. By analysing all kicking leg ankle velocity-time-courses for all executions and for all three subjects, the following similarities and characteristics were found.

**Qualitative characteristics:** In general the velocity-time-courses for the Mawashi-Geri with front leg (Chudan and Jodan) show two maximum values in the start up phase and in the snapping phase. There is a difference in the relationship between the maximum values for each subject (subject I:  $v_{max1} = v_{max2}$ , subject II:  $v_{max1} > v_{max2}$ , subject III:  $v_{max1} < v_{max2}$ ). By contrast, in the execution of the Mawashi-Geri with back leg the first maximum value can hardly be seen, since the velocity increases gradually. Only for subject II can the first maximum value be clearly identified. When the Jodan is the target area for subject II, a third maximum value appears. A possible interpretation can be given in the stretching of the supporting leg to achieve the relatively high end position of the kicking foot. For both types of Ura-Mawashi-Geri a third small maximum is located at the downward trend of the velocity curve. This is the result of the bending of the knee of the kicking leg, which is an important distinction in regard to Mawashi-Geri. In contrast to Mawashi-Geri (front leg), with Ura-Mawashi (front leg) no two maximum values appear. Only for subject II can a small first maximum value be seen. The Ura-Mawashi-Geri (back leg) shows, like the Mawashi-Geri (front leg), a first maximum value. But for each execution this first maximum value is smaller than the second maximum value. As an individual characteristic subject I performs the Ura-

Mawashi-Geri with a very small third maximum value. This means that he flexes his kicking leg only a little bit and he points to the target area by a turn of the torso. These findings permit the following conclusions. By changing the target area (Chudan or Jodan) the technique of the round kicks varies only insignificantly. In one case there is a third velocity maximum caused by an additional impulse with Jodan (see subject II). Compared to Mawashi-Geri (front leg), the execution with back leg shows no or a very small first maximum value. That means that the start up phase of the thigh is not recognized explicitly. This trend can be observed for many executions of Ura-Mawashi-Geri.

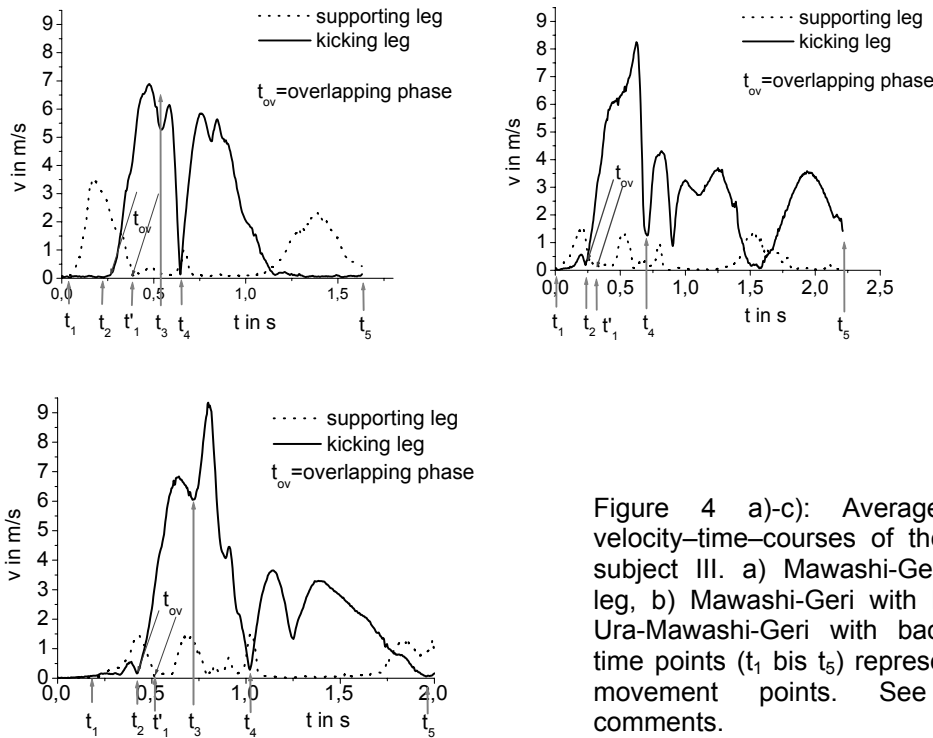


Figure 4 a)-c): Average trajectory velocity-time-courses of the ankles for subject III. a) Mawashi-Geri with front leg, b) Mawashi-Geri with back leg, c) Ura-Mawashi-Geri with back leg. The time points ( $t_1$  bis  $t_5$ ) represent essential movement points. See text for comments.

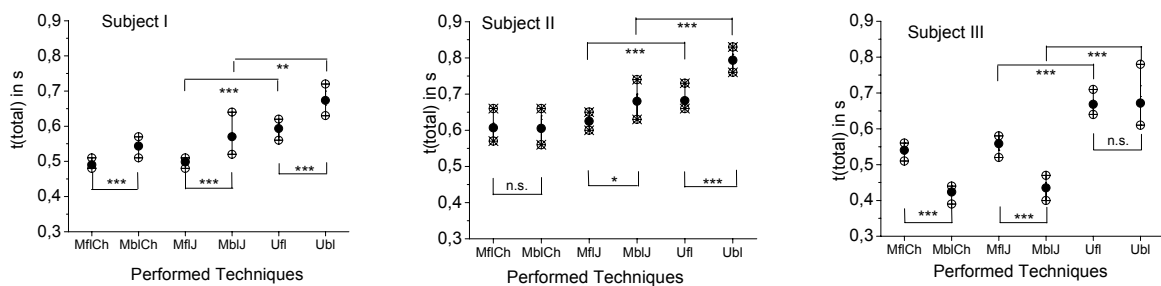


Figure 5a)-c): Average total times ( $t_4-t_1$ ) with minimum and maximum of the single performed techniques and examination of significant differences (\* -  $p < 0.05$ , \*\* -  $p < 0.01$ , \*\*\* -  $p < 0.005$ )

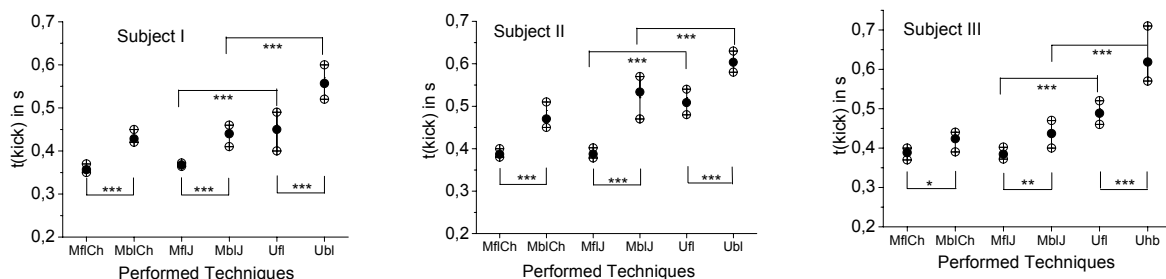


Figure 6a)-c): Average phase times of kicking ( $t_4-t_2$ ) with minimum and maximum of the individually performed techniques and examination of significant differences (\* -  $p < 0.05$ , \*\* -  $p < 0.01$ , \*\*\* -  $p < 0.005$ )

**Quantitative characteristics:** For competition and training, the duration of the total movement is an important criterion. Figures 5a) - c) show the average total times (interval from  $t_1$  to  $t_4$ ) of the movement for all subjects. The Ura-Mawashi-Geri takes the longest time as expected. But it can not be assumed that the movement duration when using the back leg is higher than when using the front leg. Many individual differences are shown.

Finally the phase time of the kicking movement (between  $t_2$  and  $t_4$ ) should be considered (fig. 6a) - c)). In comparison to the results of the total time, the phase time of the kicking movement using the back leg is longer than when using the front leg. For all subjects the shortest times were found for the Mawashi-Geri with front leg. The small range of the single times can be identified. This finding suggests a high automatism of this technique. Both variants of the Ura-Mawashi have the longest kick phase.

## **DISCUSSION:**

At first we should notice that the results obtained are based on a study with only three subjects. Consequently we should discuss the findings carefully. The following first indications about movement structures of round kicks are given. The principal aim of this study was to determine the movement phase structures for the Mawashi-Geri and the Ura-Mawashi-Geri on the basis of ankle velocity-time-courses. A separation between the preparatory or introductory phase of the supporting leg and the kicking phase could be identified. For the round kicks with front leg it was possible to quantify the start up phase of the thigh of the kicking leg ( $t_2 \dots t_3$ ) from the snapping phase of the lower leg ( $t_2 \dots t_3$ ). The individually performed techniques differ in total time as well as in kicking time. The greatest differences between the subjects in relation to the performed techniques were found in the movement of the supporting leg and in the overlapping phase respectively. This result allows us to conclude that for the training process, a shortening of the supporting leg movement by a jump into the starting position for the kicking phase (see subject III) has a positive effect on the total movement time of the round kick. The differences between the Mawashi-Geri Jodan and Chudan are individual.

## **CONCLUSION:**

By means of the ankle velocity-time-courses it is possible in principle to characterise the kicking phase of the Mawashi-Geri and the Ura-Mawashi-Geri. On the basis of these curves the duration of the total movement and the kicking phase can be determined. The qualitative and quantitative characteristics of the ankle velocity-time-courses help find specific characteristics of each round kick type and individual differences in the performance.

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