DIFFERENT VARIATIONS OF THE KARATE TECHNIQUE MAWASHI-GERI

Peter Emmermacher, Kerstin Witte, Sören Bystryzycki and Jana Potenberg

Department of Sports Science, Otto-von Guericke-Universität Magdeburg Germany

The aim of this pilot study is the characterisation of the foot moving trajectories of different variations of the Mawashi-Geri. By means of the VICON system with a sample rate of 250 fps a kinematical analysis was carried out. An essential finding was that only in the final phase of the movement the shape of the trajectory is a semicircle. From the statistical results it is concluded, that the amount of the foot trajectory is shorter when the technique is executed by the front leg than by the back leg. Even though no differences of the moving time were found. For all subjects higher maximal values of the foot velocity were determined in the case of using the back leg.

KEY WORDS: karate kick, Mawashi-Geri, kinematical analysis, movement trajektory

INTRODUCTION:

In the modern martial art Karate both arm techniques and leg techniques should be executed in the shortest time possible. Because of a change of the point system, the leg techniques became of more importance in competition. Despite the high relevance of leg techniques, there are only few biomechanical examinations until now. On the other hand, there are already examinations from Kong et al. (2000) and Lee et al. (2005) for Taekwondo. In those studies the technique “Roundhouse Kick” was analysed. Therefore, the aim of this study is the characterisation of “round” kicks as well. The object of this pilot study is the Mawashi-Geri (jap.), executed with both the front and the back leg. The target area can be the Chudan-area (jap.) as well as the Jodan-area (jap.). The systematics of the execution of these techniques is shown in Fig. 1. Because these techniques are possible by the front leg as well as by the back leg, they can be applied frequently in competition.

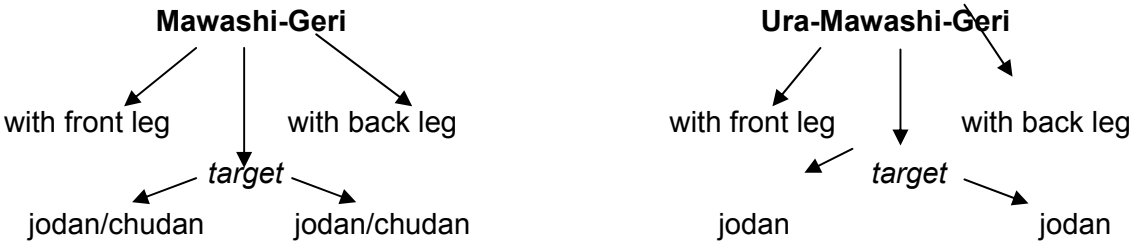

Figure 1. Systematics of the leg techniques

The duration of each variation of these leg techniques is of great importance. Factors that influence the moving time are of interest. We assume that one of the essential factors is the optimisation of the motion path of the kicking foot. Therefore we believe, that by finding the optimum configuration of the motion path these “round” kicks can be performed in the shortest time possible to and thereby become more effective. The object of this pilot study is to display and analyse the moving trajectories of the different variations of the Mawashi-Geri and to interpret their characteristics considering particularly form and length of the trajectories.

METHOD:

Three skilled male karateka participated in this study: subject I: 4th Kyu, subject II: 3rd Dan, subject III: 2nd Dan. The following types of round kicks were analysed:
Mawashi-Geri by front leg, Chudan (jap.) - chest area and Jodan (jap.) - face area: MflCh and MflJ, Mawashi-Geri by back leg (Chudan and Jodan): MblCh and MblJ.

The movements are illustrates by photos in the the presentation by Witte et al. (2007). 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). In our biomechanical analysis only the moving phase of the kicking leg, which consists of the starting up phase of the thigh until the reaching of the target area of the opponent (Witte et al., 2007) was examined. The return movement into a balanced stance was not considered.

RESULTS:

A semi-circular trajectory for Mawashi-Geri Chudan with the back leg could be stated only when the technique was executed in the primary school variation (see Fig.2).

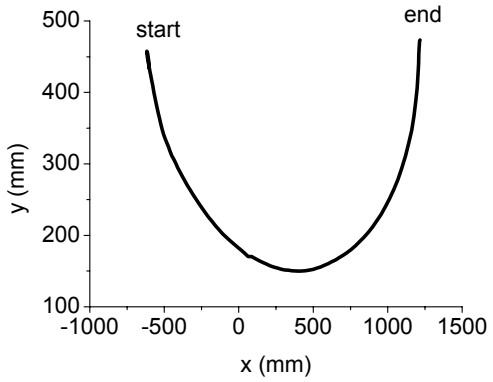

Fig.2: Trajectory (two-dimensional) of the right foot, Mawashi-Geri Chudan, back leg, subject II, x-direction: forward, y-direction: lateral-left

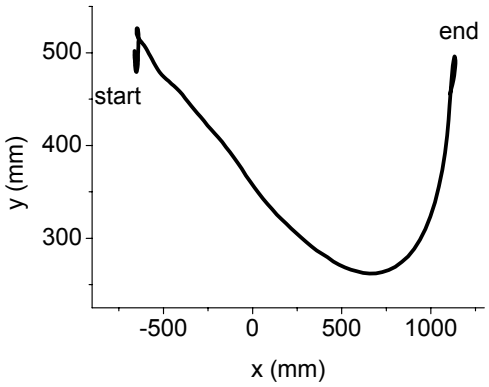

Fig.3: Trajectory (two-dimensional) of the right foot, Mawashi-Geri Chudan, back leg, subject III, x-direction: forward, y-direction: lateral-left

The Kumite execution of the technique shows at the end of the movement is a semi-circular shaped trajectory because that knee before in front (see Fig. 3). The same can be stated for the Jodan area. However, by executing the technique by the front leg, a relatively strong divergence of a semi-circular shaped trajectory can be found (see Fig. 4, 5).

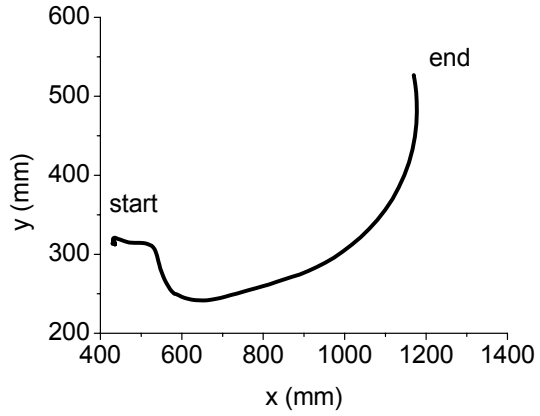

Fig.4: Trajectory (two-dimensional) of the right foot, Mawashi-Geri Chudan, front leg, subject III, x-direction: forward , y-direction: lateral-left

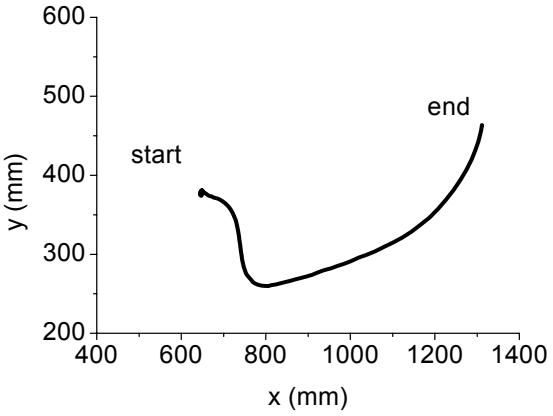

Fig.5: Trajectory (two-dimensional) of the right foot, Mawashi-Geri Chudan, front leg, subject I, x-direction: forward, y-direction: lateral-left

To summarize, a general distinction between the geometrical shapes of the trajectories was found for both performed techniques. Regarding the movement and on the basis of the two-dimensional trajectory of the kicking foot, the following phase structure can be determined (see Fig. 6 and 7): Phase I: lifting off the kicking foot until reaching of the starting position

(before the main movement (the snapping movement) is initiated), Phase II: snapping movement of the lower leg

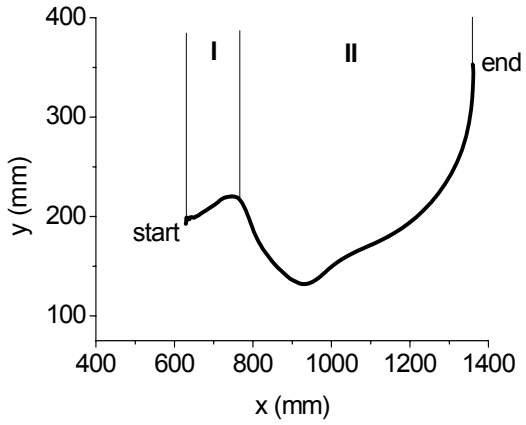

Fig.6 Trajectory (two-dimensional) of the right foot, Mawashi-Geri Jodan, front leg, subject II, x-direction: forward, y-direction: lateral-left

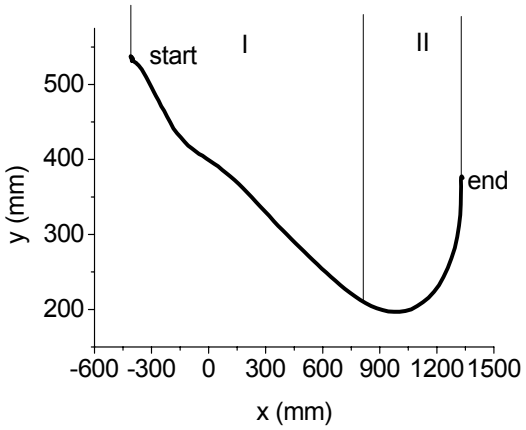

Fig.7 Trajectory (two-dimensional) of the right foot, Mawashi-Geri Chudan, back leg, subject I, x-direction: forward, y-direction: lateral-left

Table 1: Average values for length of trajectory (s), duration of kicking foot movement (t) and maximal foot velocity (v_{max}) for all subjects

Performed technique	s (m) Subj.I	s (m) Subj.II	s (m) Subj.III	t (s) Subj.I	t (s) Subj.II	t (s) Subj.III
MflCh	1,54±0,04	1,67±0,03	1,68±0,04	0,68±0,09	0,66±0,07	0,74±0,03
MblCh	2,16±0,04	2,34±0,07	2,43±0,15	0,71±0,05	0,66±0,02	0,74±0,11
MflJ	1,66±0,04	1,73±0,05	1,74±0,02	0,70±0,04	0,68±0,06	0,73±0,04
MblJ	2,27±0,03	2,66±0,15	2,56±0,08	0,74±0,05	0,76±0,05	0,63±0,05

Performed technique	v_{max}(m/s) Subj.I	v_{max}(m/s) Subj.II	v_{max}(m/s) Subj.III
MflCh	2,19±0,27	2,54±0,29	2,26±0,08
MblCh	3,05±0,21	3,50±0,13	3,34±0,48
MflJ	2,36±0,17	2,55±0,25	2,38±0,11
MblJ	3,05±0,21	3,49±0,14	3,34±0,19

To quantify the movement trajectory the following parameters were defined: length of the trajectory (s), duration of the kicking foot movement (t), maximal value of the foot velocity (v_{max}). It is noted that the duration of the kicking foot movement (t) was determined on the basis of the trajectory. So the start of the movement is distinguished by the time when the heel lifts off, even though the velocity-time-course of the foot is not increasing. Therefore, differences regarding the movement time, which was calculated by the means of the velocity-time-course (Witte et al., 2007), appear. Table 1 shows the average values of the parameters characterising the foot trajectory. Because similarities and differences between the techniques executed by the front leg and by the back leg are of interest significant differences were determined by means of the Mann-Whitney-U-Test (Table 2). From these statistical results it is concluded, that the foot trajectory is shorter when the technique is executed by the front leg. Even though no differences of the moving time were found. For all

subjects higher maximal values of the foot velocity were determined when the techniques were executed by the back leg. These results can be explained by a longer acceleration path of the kicking leg.

Table 2: Determination of significances (Mann-Whitney-U-Test) between the techniques executed by the front leg und by the back leg regarding its particular parameters: average length of trajectory (s), duration of kicking foot movement (t) and maximal foot velocity (v_{max}) of all subjects

	MflCh vs. MblCh	MflJ vs. MblJ
s (subj.I)	p=0,006	p=0,005
s (subj.II)	p=0,006	p=0,004
s (subj.III)	p=0,004	p=0,006
t (subj.I)	p=0,169	p=0,141
t (subj.II)	p=1,00	p=0,025
t (subj.III)	p=1,00	p=0,31
v_{max}(subj.I)	p=0,006	p=0,006
v_{max}(subj.II)	p=0,006	p=0,004
v_{max}(subj.III)	p=0,004	p=0,006

DISCUSSION

The displaying of the trajectory makes it possible to show differences between the basic school technique (Kihon – jap.) Mawashi Geri and its Kumite variation. This study was performed with three subjects only. To optimize this technique it is necessary that even more athletes be tested. The result of this study shows the differences of the trajectories of the Mawashi Geri. The examined leg technique Mawashi Geri describes only partially a semi-circular shaped motion path. In addition, major differences between the execution of the technique by the front leg and by the back leg were discovered. The trajectory of the Mawashi Geri by the back leg has an almost flat course at the beginning, then the trajectory becomes semi circular shaped towards the end of the movement. In contrast(Fig. 6 at the begining), when the Mawashi Geri is executed by the front leg the trajectory differs strongly from a semi-circle.
The executed techniques by the back leg have a longer acceleration phase and therefore a higher maximum velocity.

CONCLUSION

If one looks at the trajektory of the Kumite execution of the Mawashi Geri, a semicircle is to be seen only in the final phase of the movement.
In the first phase, the beginning of the movement of the kicking leg, the movement is not semi-circular. At the end position of the first movement segment, the lower leg points down and outwards. The foot position is necessary to perform the following semicircular shaped motion path. The cause for this trajectory is, that the opponent is not supposed to identify this movement.

REFERENCES:

Chen Lin Lee, Yu Fan Chin & Yu Liu (2005). Comparing the difference between front-leg and back-leg roundhouse-kick attacking movement abilities in taekwondo. In: Qing Wang (ed.) Proceedings of XXIII International Symposium on Biomechanics in Sports. Vol.2

Pui-Wah Kong, Tze-Chunh Luk & Youlian Hong (2000). Difference between taekwonondo roundhouse kick executed by the front and back leg – a biomechanical study. In: Y. Hong & D.P. Johns (eds.) Proceedings of XVIII International Symposium on Biomechanics in Sports. Vol.1

Witte, K., Emmermacher, P., Bystrzycki, S. & Potenberg, J. (2007). Movement structures of round kicks in karate. Proceedings of XXV International Symposium on Biomechanics in Sports.