

## ACCELERATION COURSE OF FIST PUSH OF GYAKU-ZUKI

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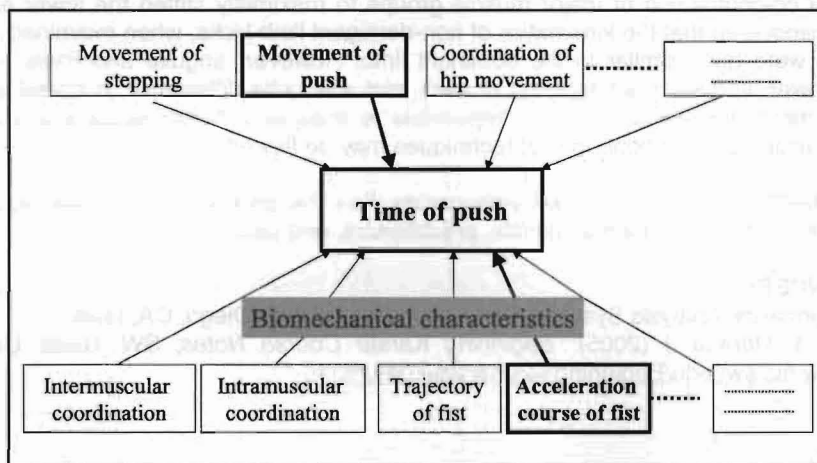
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The purpose of this study is the presentation of a biomechanical pilot study researching Gyaku-Zuki in karate. Particularly, the influence of the acceleration of the fist to the pushing time were analysed. On the basis of the results of five karateka having different levels of performance, the effect of the acceleration can be determined as an individual characteristic.

**KEY WORDS:** karate, Gyaku-Zuki, acceleration

**INTRODUCTION:** In the modern martial arts a successful competition requires the realization of the techniques in shortest time. Therefore and because of the continuous improvement in performance, kinematical analyses of these techniques are necessary. For instance, in competition of Taekwondo leg techniques are important, so Luk et al. (2000) studied a semicircle kick. In comparison within other modern martial arts fist pushes (for example the Gyaku-Zuki in karate) are relevant to achieve points in competition. For this reason the biomechanical characteristics of the Gyaku-Zuki are of interest. The Gyaku-Zuki is a reverse push: the left or the right leg is moved forward and the reverse arm executes the fist push (Lind, 1999).

It can be assumed that the time of the push is important for the total movement time of this karate technique. Thus, the research of the components influencing the time of the push is worth analysing. Figure 1 shows some components, for example partial movements as well as biomechanical quantities and relations. It is supposed that the acceleration behavior of the pushing fist has an effect on the time of the push. Therefore, the purpose of this study is the analysis of the acceleration course of the pushing fist. Furthermore several movements of the push are included.



**Figure 1** Components influencing the pushing time of Gyaku-Zuki.

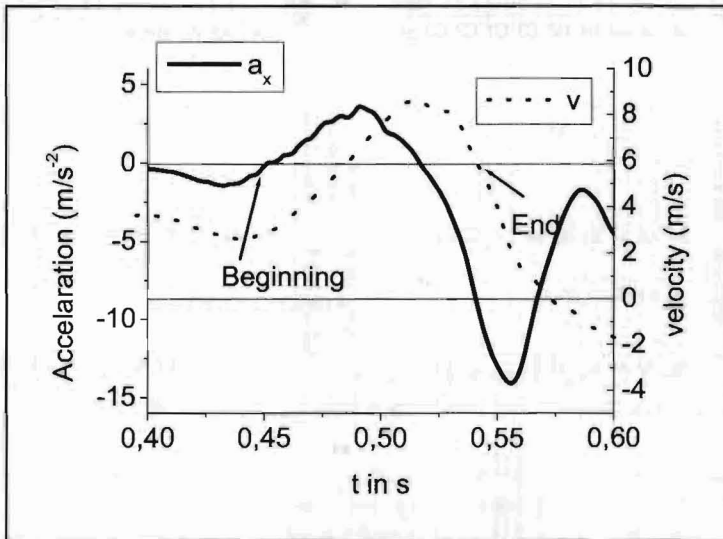
**METHODS:** Five male competitive karateka with different levels of performance participated in this study: subject 1 (S1): 3<sup>rd</sup> Dan, subject 2 (S2): 4<sup>th</sup> Kyu, subject 3 (S3): 1<sup>st</sup> Kyu, subject 4 (S4): 1<sup>st</sup> Kyu, subject 5 (S5): 2<sup>nd</sup> Kyu. The techniques were executed under the following conditions:

- A: Gyaku – Zuki with hip rotation,
- B: Kizami – Zuki/Gyaku – Zuki,
- C: Uraken – Uchi/Gyaku – Zuki.

Every movement or movement combination (B and C) was repeated thrice. The experimental construction included several measuring systems:

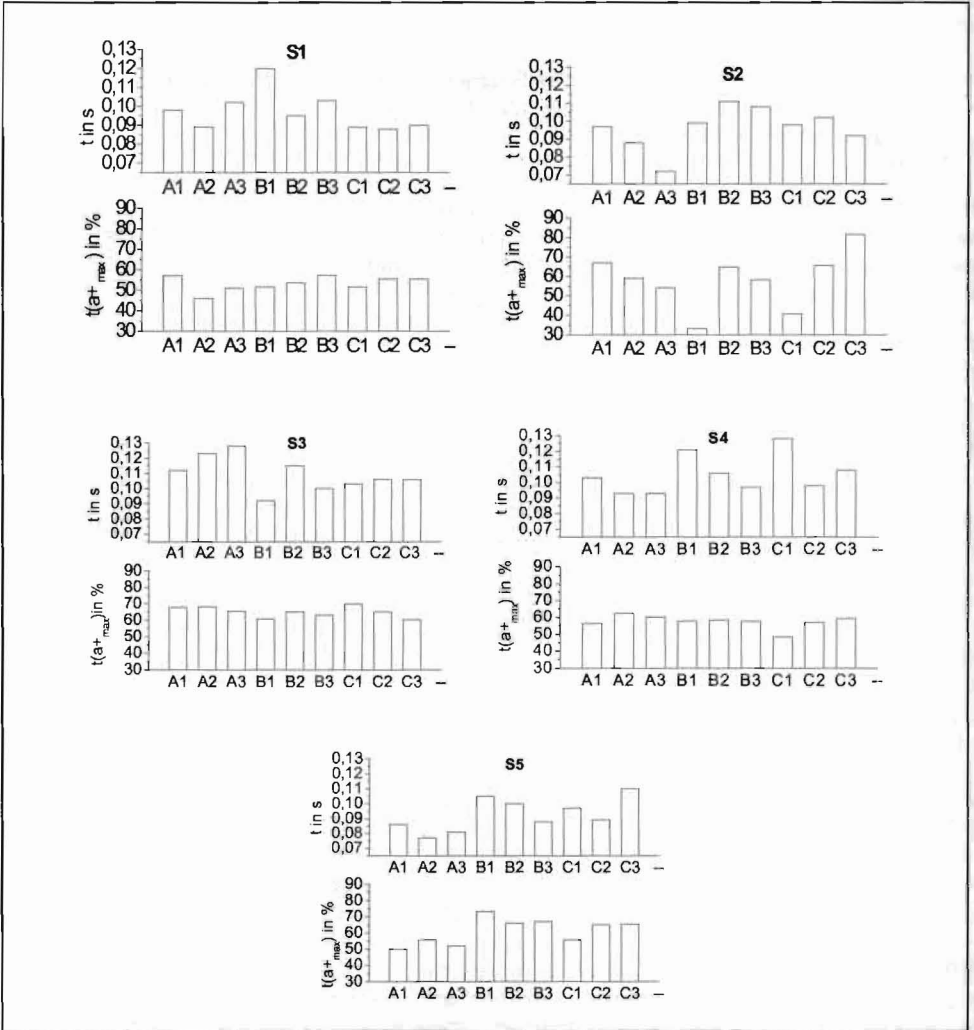
- IR-system AS 200 (Company LUKOtronic), 3-dimensional, sample rate 200 Hz,
- Video analysing system (SIMI Motion), 3-dimensional, sample rate 200 Hz,
- Accelerometer 2-dimensional, sample rate 1000 Hz,
- EMG, sample rate 1000 Hz,
- Trigger.

The biomechanical analysis refers only to the pushing movement of the fist. The beginning was defined as the point of time when the acceleration increases (s. Figure 2), the end of the movement was identified by the velocity-time-course, particularly when the velocity changes its sign from "+" to "-".



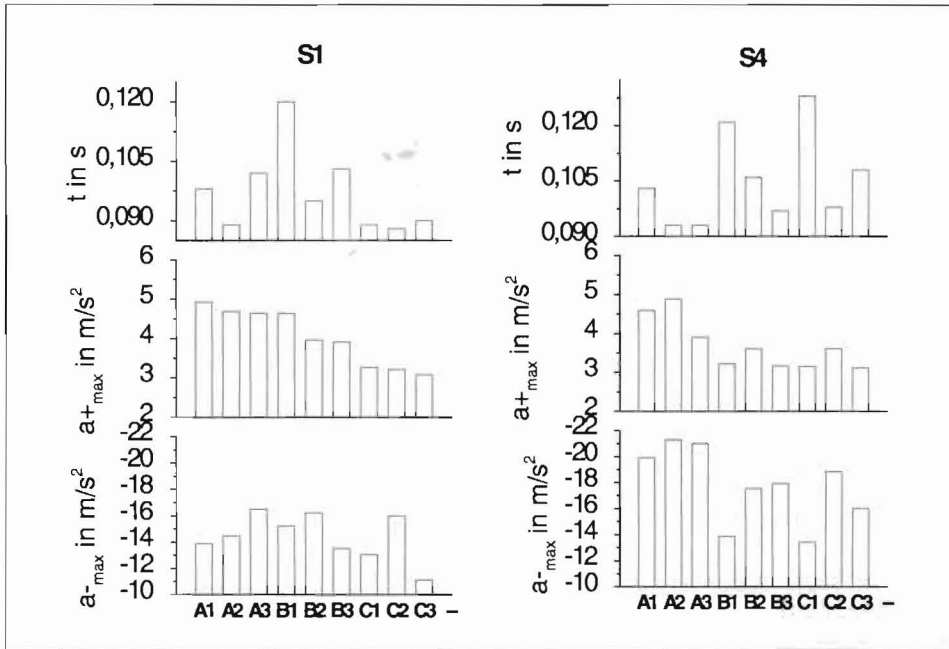
**Figure 2** Time course of the fist acceleration and fist velocity in pushing direction. Beginning and end of the arm extension are marked.

**RESULTS AND DISCUSSION:** Figure 3 represents the pushing times and the percentage proportions of the positive acceleration time. As shown in the charts the pushing time lies in the range from 0.072 s to 0.120 s. Significant differences between the pushing times of the technique combinations (B and C) and the pushing times of the single techniques (A) of Gyaku-Zuki could not be found for all subjects. Furthermore, in 96.4 % of all exercises the time duration of the positive acceleration is greater ( $t(a_{+max}) > 50\%$ ) than the time duration of the negative acceleration. But the percentage proportions of positive acceleration time is individual: subjects 2 – 5 have explicit higher values than subject 1. This can be explained by the graduation (3<sup>rd</sup> Dan) of the subject 1. The correlation analysis (Pearson) shows only for subject 4 a significant relationship ( $p < 0.04$ ,  $r = -0.75$ ). For the subjects 1, 3 and 5, an increased percentage proportion of positive acceleration time could be observed, but only if the pushing time increased as well. That means, the techniques with the shortest pushing times are characterized by relative long times for the deceleration of the movement.



**Figure 3 Pushing time (t) and percentage proportion of positive acceleration time (t(a+max)) for all five subjects and experimental conditions.**

In addition to Figure 3, the maximum values of the positive and the negative acceleration and their influence on the pushing time are interesting. Figure 4 shows the exemplary results for the subjects 1 and 4. However, significant correlations between the pushing time and the maximum positive acceleration were not found. Only subject 3 and 4 have a tendency to be significant: the techniques with small pushing times exhibit high maximum positive accelerations. According to the maximum negative acceleration a significant correlation ( $p < 0.01$ ,  $r = 0.95$ ) was found only for the subject 4. For all other subjects no tendencies were pointed out.



**Figure 4** Pushing time ( $t$ ), maximum positive acceleration ( $a_{+max}$ ) and maximum negative acceleration ( $a_{-max}$ ) of the pushing fist for subject 1 and subject 4.

**CONCLUSION:** In the present pilot study the influence of the acceleration behavior of the fist regarding to the pushing time of the Gyaku-Zuki was researched. The results of five subjects explain that the effect of the acceleration is influenced by individual characteristics. However, the data seem to indicate that for the techniques with the shortest pushing times the duration of the deceleration is relative long. This findings suggest that the pushing time depends on further biomechanical quantities and relations. It is assumed that the quality rating of the single factors is different. Closing it was established that a push movement does not influence the pushing time of Gyaku-Zuki.

**REFERENCES:**

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