

KINEMATICAL MOVEMENT EVALUATION OF SOME STRAIGHT-LINE KARATE TECHNIQUES

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Karate is more than a thousand years old, Martial Art consisting of kicks, punches and strikes. The participants - "karatekas" - steadily made it perfect, improved its' motions, so karate could become competitive. Mending the movements, acquiring new experiences and increasing efficiency are very important factors for all. Such is the case for karate, as well. Karate specialists have issued many karate-books recording their experience, but these are missing the biomechanical attitude.

MATERIAL AND METHOD

There are always statistics presented in Kyokushin Karate World Championships, which are the most frequently and most efficiently applied to fighting movements /Sterkowitz 1984/. He determined the two most common used fighting techniques, the "mawashi geri gedan" /circular kick against the thigh/ and the "seiken tsuki chudan" /straight punch pointing to the trunk. This last but not the least technique can be well recorded and evaluated from two-dimensional motion pictures.

In the present study the straight punch was achieved in the air from a stable fighting position with back hand by a 3rd Dan /B. I. Hungarian/ and two 5th Dan /A.I. Hungarian and H. C. English/ karate masters. Some of their competition results: H.C.: European champion two times, World championships 8th and 5th placed. B.I.: Hungarian champion six times, European 3rd placed in fighting. A.I. has no significant result.

Evaluation of movements examined the center of gravity of the fist. That is to say because the striking right arm's fist represents the efficiency of the whole body taking part in the punch. Karate movements can be divided into more parts than other sport-movements. Evaluating the movements, comparing them, and adjusting the faults is easier in this way. Establishing the phases I focused on the movements of the fist of the striking arm.

We took the motion picture by the means of an ECLAIRE 16 mm camera: artificial light /6000 W/; revolution 75 Hz; distance 20m. The objective of the camera was placed 1.2 m above the ground. Co-ordinates were recorded by NAC half-automatic motion-analyser. Calculations were achieved by the means of IBM PC Computer /programs made by L. Toth/.

In this paper I focused on the Karate punches and the time a punch be achieved. Some investigators who have studied this area are Edgerton and Miller in Canada /1973/. Examination was performed in the stroboscope LAB of the M.F.I. by the means of Choi Bong Hi (9th Dan great-master). The straight punch was achieved during 0.03s /Harmat 1984/. Conditions of the experience or the conditions of the punch were not fully described: from what kind of position was the punch achieved, by front hand /oi/, or back hand /gyaku/; in the air or against target surface; what was the purpose of the punch etc. Harmat's book didn't mention Miller's experience whether this very short 0.03s was the period of the full punch or only the punch-out time /the arm stretching forward/. The problem is that the literature dealing with Karate doesn't distinguish phases in each techniques. Establishing phases makes the examination more exact and standard, comparing the techniques is then easier, similar to other sport-movements, where these are described. That's why the Karate-techniques /straight kick-mae geri; straight punch - seiken tsuki chudan/ examined by me; was divided into phases. The movement - phases of the kicking leg were determined /Bardosi 1984; Bardosi-Nagy 1987/ as the kick is moving; preparing - real kick - contact phase - drawing back - return back to the original position. As to the straight punch the phases are: preparing - punch out /real punch/ - contact time /contact phases/ - drawing back.

Preparing phase:

Movement right, after the fundamental rest stable position achieved by the karateka preparing the real punch out, until it's beginning; /the center of gravity of the fist begins to move forward in the direction of the attack/.

Punch out:

Achieved by the karateka toward his fictitious or real target point; the phase is shown by the punching arm /the punching fist/ moving forward until the stretching of the arm is complete.

Contact phase:

The punching arm is stretched out in front of the body or in touch with the target surface.

Drawing back:

Sum of the movements from the stretched out position to the fundamental original fighting position.

In our present research the physical facilities of the tested Masters of Karate were dissimilar from one another. Rohrer-index: A.I.: 1,33 B.I.: 1,40 H.C.: 1,48. In our present three cases - the case of the three straight punches achieved by the Masters - you can see significant differences with regard to the complete way and the necessary time to perform the punch by the center of gravity of the fist. Searching the phases reveals these differences as seen in Figure 1.

Phase	Name	A.I.	B.I.	H.C.
Whole movement (100%)	s (m)	2.421	1.635	1.977
	t (s)	0.754	0.481	0.767
Preparing phase (t)	Δs (t)	34.5	0.9	14.0
	Δt (t)	58.9	2.7	37.2
Punch out (t)	Δs (t)	39.0	42.9	41.6
	Δt (t)	19.0	35.2	27.1
Contact phase (t)	Δs (t)	—	—	—
	Δt (t)	—	—	—
Drawing back (t)	Δs (t)	26.6	56.4	44.9
	Δt (t)	22.5	62.2	35.5

Figure 1:

In Figure 1 striking the eye is the contact phase where parameters are not recorded. It does not mean that this phase does not exist, the reason is that the contact phase is shorter than 0.01s and thus missed by sampling at 75 Hz. Presentation of this is important as it concerns the whole system. After all punches against target surface this phase was well registered /Bardosi,1984/.

In two cases significant disproportions were determined to prejudice each phase. A.I.'s preparing phase took too much time from the whole movement's time, similarly the prejudice of B.I.'s disproportioned the time drawing back phase.

RESULTS

After the evaluation of straight punches /seiken tsuki chudan/ from phase to phase I present the three sort of performance separated by means of diagrams. Sequence of diagrams is the same in the all three cases.

At first you can see the pattern of the center of gravity of striking fist /Fig. 2,5,8/ drawn by the computer. The fist in the origin state is put down as the origin /0.0/. The preparing and punch-out phase are shown by the sign ">", the pattern performed by the center of gravity of the fist during the drawing-back phase is shown by

the sign ">>". Diagrams can be seen in the second place of the sequence /Fig 3,6,9/. Calibrations and captions on the time-axis /horizontal line/ represent the pictures following each other on the film. Taking the film at the rate of 75 Hz, produces a time between each picture of 0.013s. Sign I presents the period of the preparing phase, sign II shows the punch-out phase and the drawing-back phase is sign III.

At last you can see the acceleration-time diagrams /Fig 4,7,10/, where the calibration on the horizontal line is the same as above.

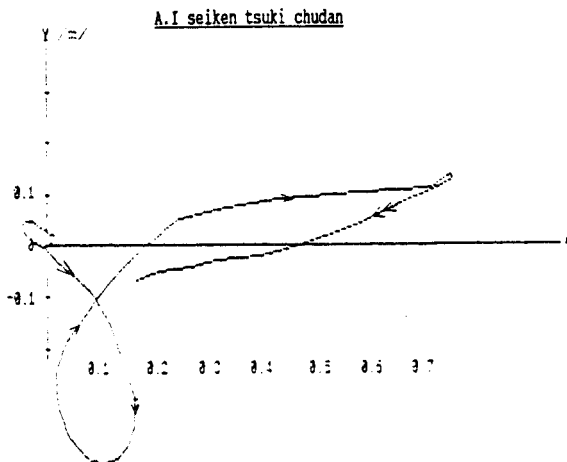


Figure 2:
Path of the center of gravity of the fist./A.I./

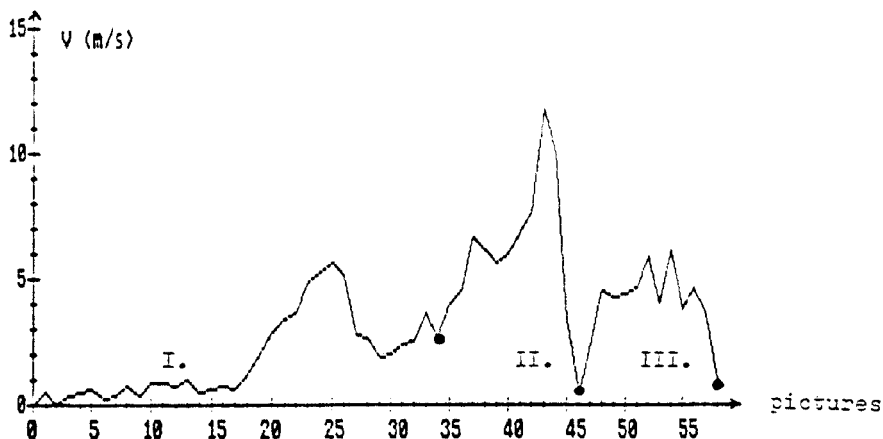


Figure 3: Velocity-time diagram. /A.I./

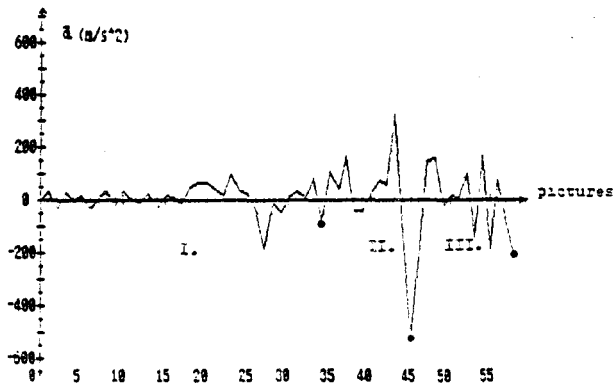
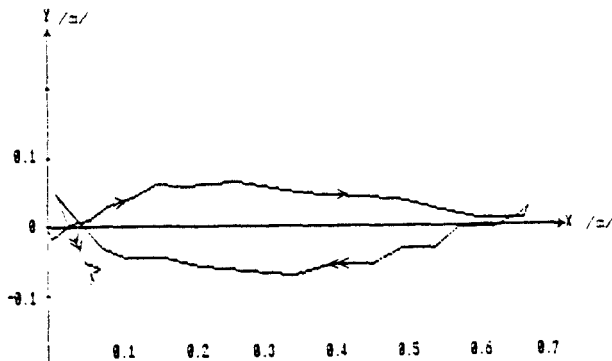


Figure 4: Acceleration-time diagram /A.I./

In the case of A.I.'s "straight punch" the center of gravity of the fist passed altogether 2.421 m / 4 phases/ during 0.754s. Searching Figure 2 you may rightly ask it is a straight punch? As the Japan determination says: pushing punch toward the trunk of the body by fist /seiken tsuki chudan/. This technique should approach - on basic level - the straight line as shown in Fig.5. Our searching represents that the techniques formed by individual differences from the ideal. A.I.'s center of gravity of fist - after a relatively long preparing phase - reached the highest momentary velocity $v(t) = 11.81 \text{ m/s}$ /Fig.3/ among the three examined persons. The striking arm following the maximum momentary speed is in the stretched out position after already 0.026s /Fig.4/.

B.I seiken tsuki chudan



• Figure 5: Path of the center of gravity of the fist /B.I./

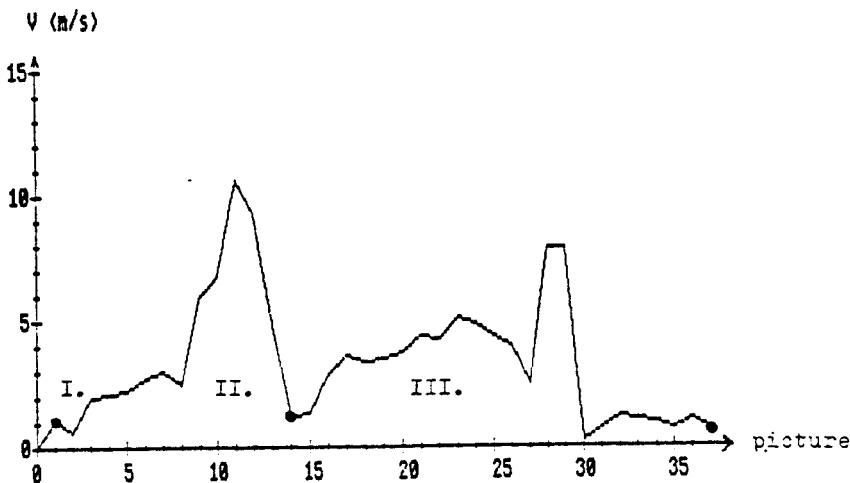


Figure 6: Velocity-time diagram /B.I./

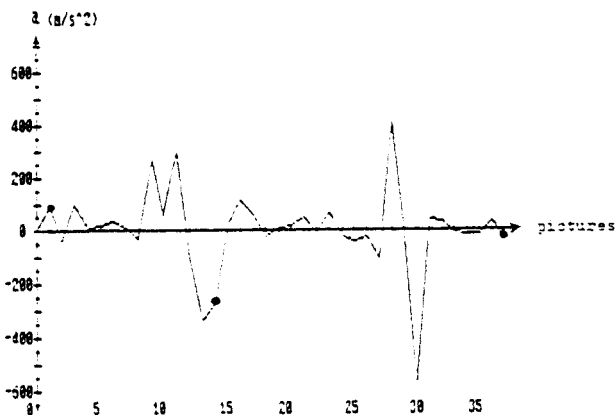


Figure 7: Acceleration-time diagram /B.I./

In the case of B.I.'s "straight punch" the center of gravity of the fist passed 1.635 m in 0.481 s. The center of gravity of his fist during the total punch and during the punch out phase passed the shortest distance $s=0.715$ m from the initial position to the terminal position. The center of gravity of his fist reached the highest momentary velocity $v(t)=10.64$ m/s /Fig.6/ 0.039 s before the stretching the arm out. You can see the most extreme parameters in the changes of the speed of the center of gravity of his fist both in punch-out and drawing-back phase.

H.C. seiken tsuki chudan

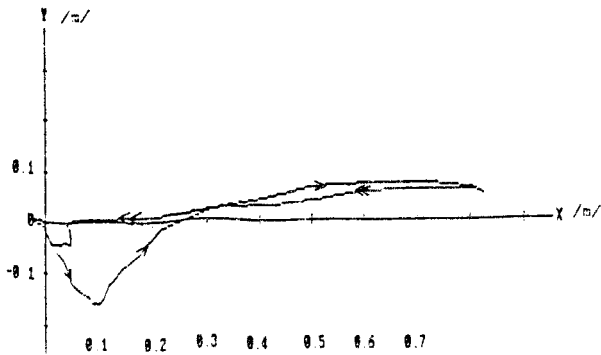


Figure 8: Path of the center of gravity of the fist /H.C./

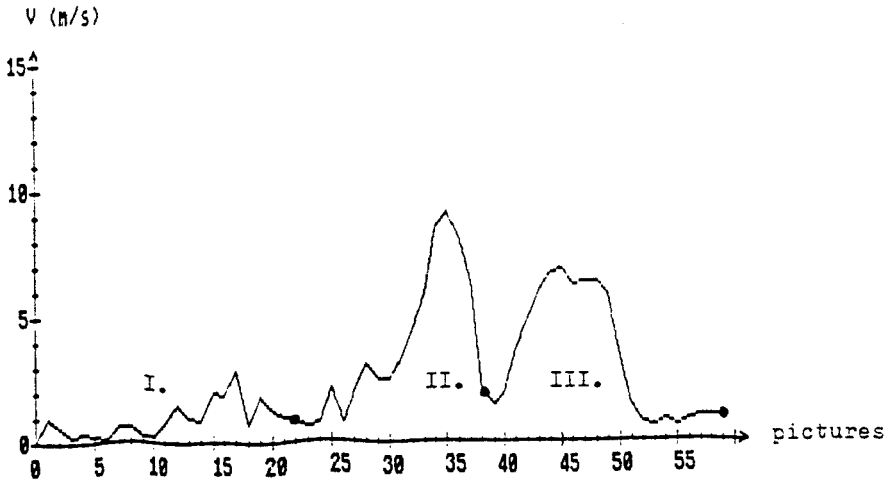


Figure 9: Velocity-time diagram /H.C./

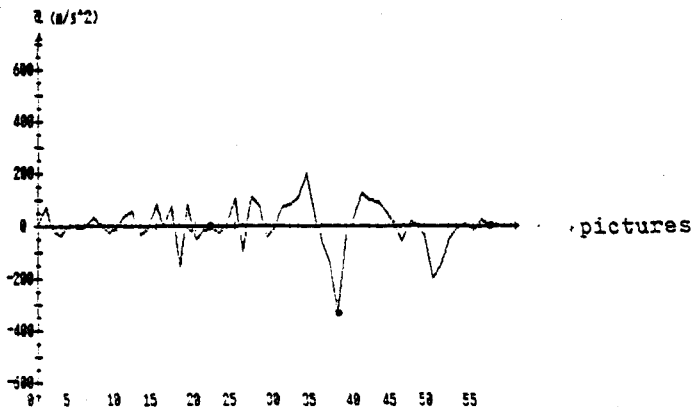


Figure 10: Acceleration-time diagram /H.C./

In the case of H.C.'s "straight punch" the center of gravity of his fist passed altogether 1.973 m during 0.767 s. In the preparing phase he drops his fist and from this position he moves it toward it's target along an ascending line /Fig.8/. the drawing-back phase approaches the straight line in the best way. His maximum momentary speed was $v(t)=9.07$ m/s /Fig.9/.

SUMMARY

These researched Karate punches are the most frequently applied and most efficient techniques used in fighting. These techniques are achieved in very short time and show significant individual variances, nevertheless one can find more similarity at the same time. These similar marks make it possible to divide the Karate punch into phases and thus make the evaluation easier.

After all these tests further questions arise, however the answers to them are too hard among the bad hungarian technical circumstances.

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