KINEMATICS OF LOWER AND UPPER EXTREMITY MOTIONS DURING THE FENCING LUNGE: RESULTS AND TRAINING IMPLICATIONS

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INTRODUCTION: The fencing lunge is one of the motions most used in this sport: a substantial element is represented by action speed, avoiding or reducing the possibility of a defense or counterattack action by the opponent athlete. The objectives of this study are the presentation and valuation of the actual state of the execution of the fencing lunge on the basis of quantitative aspects using data of a three-dimensional analysis of lower and upper extremity movements.

METHODS AND PROCEDURES:

Test persons

Four female fencers served as test persons in the investigation. Since a statistical analysis is not intended here, the limitation of the number of test persons is justified. The age of the test persons was 16-17, the training years ranged from 5 to 9 years.

Experimental setup

The test persons executed at least eight trials performing the fencing lunge at maximal speed. The movement began from a normal distance (chosen individually) from a wall target. The kinematics of the movements were obtained using an infrared measuring device (SELSPOT II) registering the position of eight LED markers attached to the test persons at the following locations: foil guard, elbow, shoulder, hip, knee, ankle, heel and toe, each on the fencing side of the body. Measurements were taken using a frequency of 100 Hz. In each trial, a time span of 5 seconds was given (corresponding to a total of 500 measurements). An overview of the experimental situation is given in Figure 1 (cf. next page).
All parameters measured (coordinates of the markers and hit signal given by the electrical scoring apparatus) were fed into a computer for further evaluation. A set of variables as part of all results was chosen with respect to the importance in fencing as follows in Table 1.

Table 1: Definition of parameters in the fencing lunge

parameter	definition
V1	maximal horizontal velocity of the foil (m/s)
V2	maximal vertical velocity of the foil (m/s)
V3	maximal horizontal velocity of the hip (m/s)
V4	horizontal foil velocity at hit time (m/s)
V5	vertical foil velocity at hit time (m/s)
V6	horizontal hip velocity at hit time (m/s)
V7	vertical hip velocity at hit time (m/s)
V8	duration of the lunge movement (sec)

Mean values and standard deviation of these parameters were computed for each test person. Besides the main parameters defined above, the time dependent velocity curves of all marked body points were computed. Additionally, several time dependent angles (e.g. of the knee and elbow joints, angle between trunk axis and upper arm) on the fencing side were constructed. The time history of all parameters was considered to be a valuable tool to estimate the repetition level of the lunge movement.

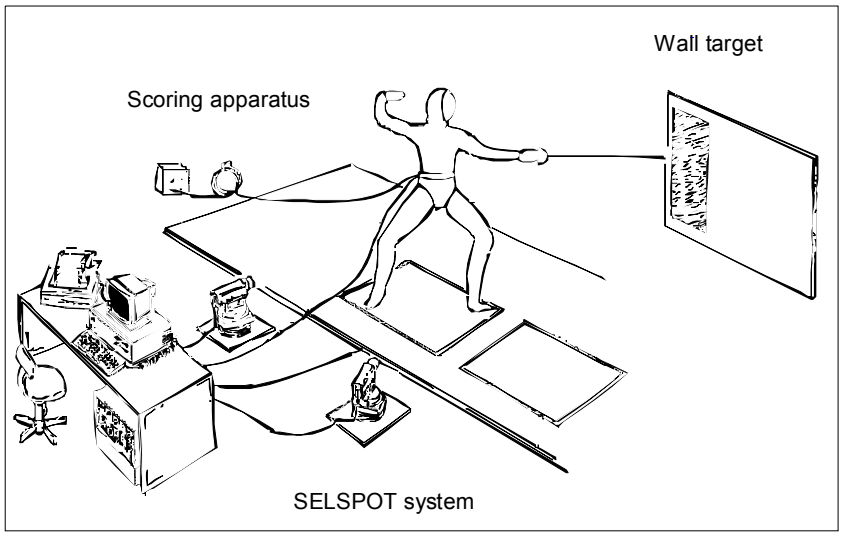

Fig.1: Experimental setup (overview)

RESULTS:

The interpretation of the numerical results consists first of a description of the actual 'state of the art' of executing of the fencing lunge. In terms of the parameters defined in Table 1, the following results were found (Table 2).

Table 2: Maximal (max.), mean ($\bar{x}$) value and standard deviation (sd) of the velocity parameters (V1 - V7, cf. tab.1)

	JW			**RW**			**MT**			**SR**		
Var*	max.	$\bar{x}$	sd	max	$\bar{x}$	sd	max.	$\bar{x}$	sd	max	$\bar{x}$	sd
V1	3.91	3.71	0.16	3.86	3.65	0.18	3.79	3.43	0.27	3.40	2.92	0.39
V2				1.34	1.28	0.09				0.47	0.43	0.06
V3				2.33	1.84	0.28	2.33	2.15	0.20	2.28	2.10	0.15
V4	3.56	3.34	0.17	3.20	2.99	0.28	3.45	3.01	0.23	2.96	2.50	0.29
V5	1.23	1.04	0.14	1.36	1.31	0.07	1.28	1.18	0.05	0.70	0.54	0.15
V6	1.51	1.42	0.12	1.84	1.69	0.09	2.33	0.26	0.22	2.28	2.13	0.11
V7	-0.92	-0.70	0.20	-0.78	-0.67	0.06	-0.58	-0.42	0.10	-0.54	-0.66	0.10

*) all values in m/s

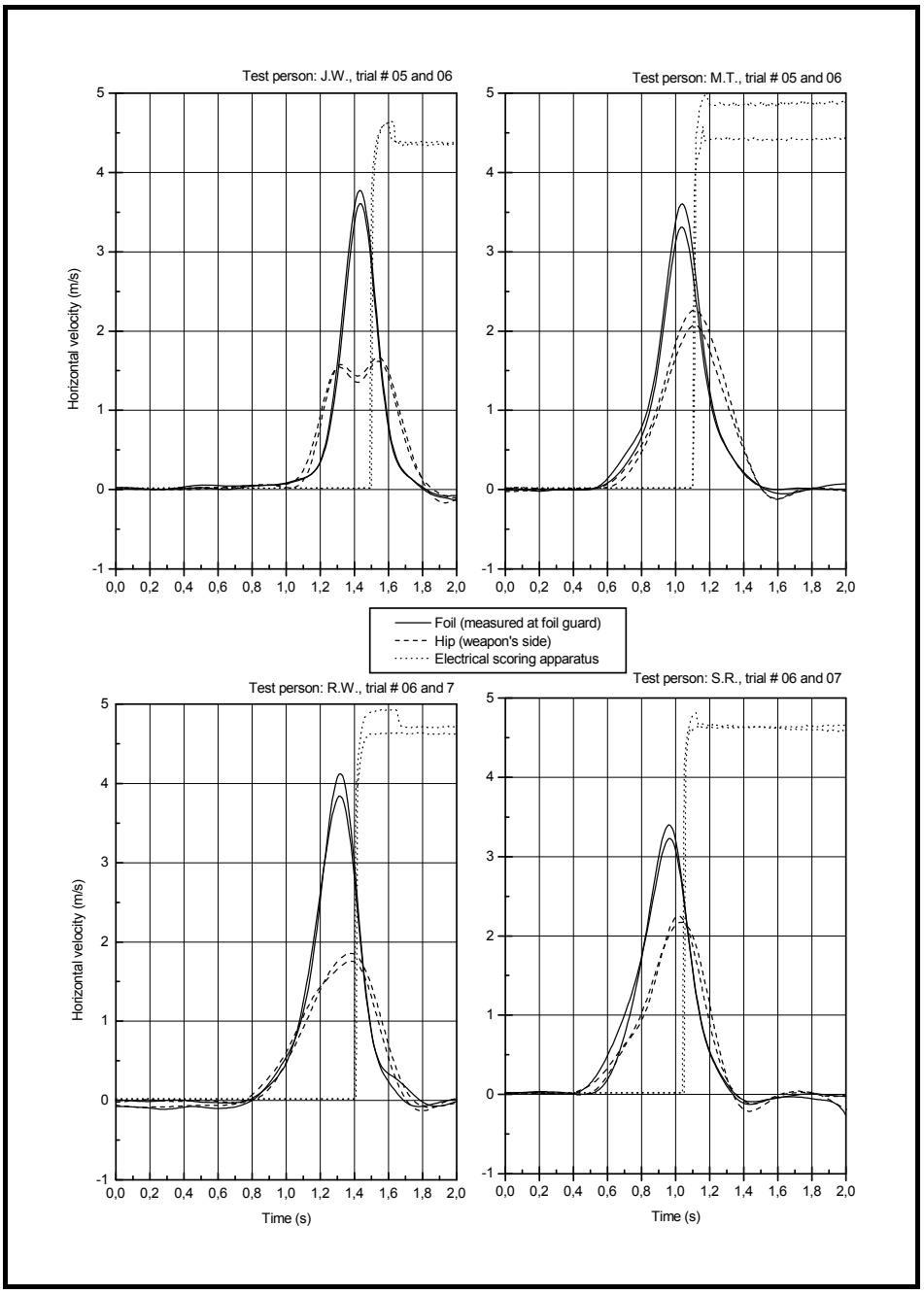

Fig.2: Velocity - time curves of selected points of the test persons executing the fencing lunge, presentation of two trials.

Fig. 2 shows the velocity-time curves of the foil (as a sum of the contributions of upper and lower extremity) and the hip on the weapon's side representing the contribution of the lower extremity alone. As will be seen, all test persons showed a very good reproduction of the lunge movement. Besides this, each person demonstrated an individual characteristic of the curve form.

Considering the results given in Table 2, it can be stated that the standard deviation value of V1 is relatively small as compared to the mean value. In all cases, the horizontal velocities of foil and hip show a slight decrease from the maximal values. The angles of the foil velocity vector relative to the horizontal direction show no great differences between the time point at maximal velocity and time point of hitting the wall target, the absolute values being in the range of 8 to about 20 degrees, varying individually.

An interpretation of the curves from the viewpoint of the coach can be given as follows:
– For all test persons a similar form of the curves could be registered, the time point of hitting the wall target is located very close to the velocity maxima (up to 0.1 seconds) - this result is in agreement with the opinion of CIVRNY (1982, 81).
– Test persons M.T. and S.R. perform a regular scheme of the lunge movement, beginning with stretching the fencing arm followed by the action of the lower extremity, corresponding the rules of the FIE (International Fencing Federation). Here, the observer registers good coordination between arm and leg action as pointed out by Kerstenhahn (1967, 99)
– Test persons J.W. and R.W. show a different coordination of lower and upper extremity movements: In these cases, the lower extremity is evidently activated at first, the arm action being executed later. So, an incorrect execution could be documented here.

CONCLUSIONS: The use of measurement results as part of a sort of diagnosis of the fencing lunge may have the following implications:
– Objective control in correcting the movement
– Estimation of the degree of performance by evaluation of the movement
– reproduction
– Possibility of classifying the individual fencer using absolute data
– Gain of measures of coordination parameters by combination of different data.

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