Complex Investigation of Successful Weightlifting Exercises

A. Barabás, Gy. Fábián
University of Physical Education, Budapest, Hungary

INTRODUCTION

The examination of weightlifting movements has great significance in the contemporary research of training methodology from a number of aspects. One must mention here that

— on the one hand, weightlifting is a separate field of sports, as a result, the examination of its movements contributes to the enrichment of the knowledge accumulated by the specific theories of various fields of sports;

— on the other hand, weightlifting, is «the lifting of a weight» is the most widely used method in the process of developing different abilities in all fields of sports.

Of course, the technical exercises used in competition, and those used in developing different abilities, are by no means equal. It is, however, beyond doubt, that the efficiency of both training and competitive performance can be increased only by biomechanical perfect, properly executed exercises.

MATERIAL AND METHOD

The present study illustrates the results gained from 34 successful snatch exercises, carried out under laboratory control, of 10 weightlifters of the Hungarian National and Junior Teams.

The anthropological characters were determined according to the Martin method. Proportionalities were calculated from the raw figures required by the Hanavan mathematical model, while the weights of the

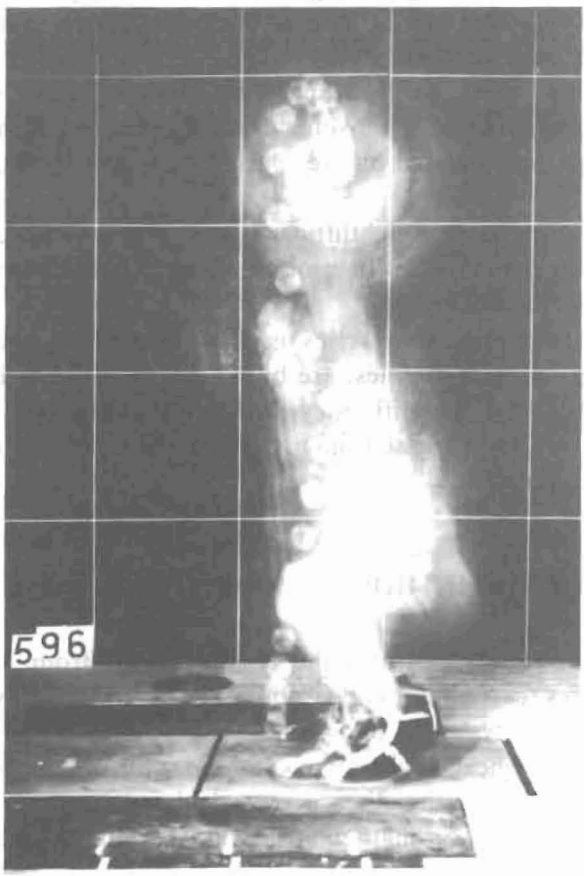
separate body parts /segments/ were determined by regression equations used by Clauser and his colleagues.

For measuring force during the exercises a so-called measuring platform, built into the weightlifting pulpit, was used

RESULTS AND DISCUSSION

The dynamogram of snatching was regarded as the object of examination. On the stulized force curve the peaks and values of force, both serving the «lifting» of the weight, the ending of «going under» the weight, and finally, «counterholding» (F_5) measured during the stopping the weight falling dawn, were distinguished.

The dynamism and explosiveness of the exercise was measured by the so-called force increase (/Fig. 1/ F, α).



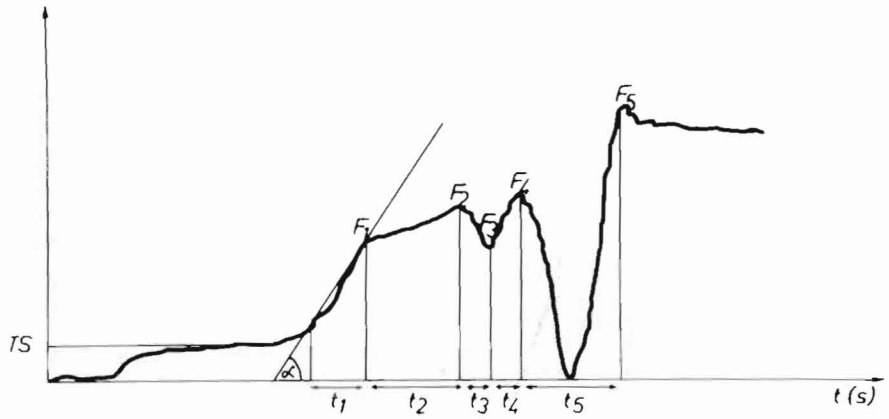


Fig. 1. The dynamogram of vertical force during the successful snatch exercise.

Critical points of phases can be distinguished on the stylized motion curve. They are indicated in the following way (Fig. 2.):

— *«pulling»* movement /A/, its final position /1/, the projection of the final position /a/, its co-ordinates /x_1y_1/;

— movement of *«explosion»* /B/, its final position /2/, the projection of the final position /b/, its co-ordinates /x_2y_2/;

— movement of *«going under»* /C/, its final position /3/, the projection of the final position /c/, its co-ordinates /x_3y_3/;

— movement of *«sitting in»* /D/, its final position /4/, the projection of the final position /d/, its co-ordinates /x_4y_4/.

Sign (−): the weightlifter begins the movement by pulling the weight towards himself, in relation to the basic position;

Sign (+): the weightlifter begins the movement by «pushing away» the weight from himself.

Similarly to dynamograms the variations of movements among, and within, individuals show themselves in the kinematic parameters of the course of movement, too. In order to compare them the characteristic parameters of a successful exercise are determined by the co-ordinates of typical points of phase as so-called discreet points.

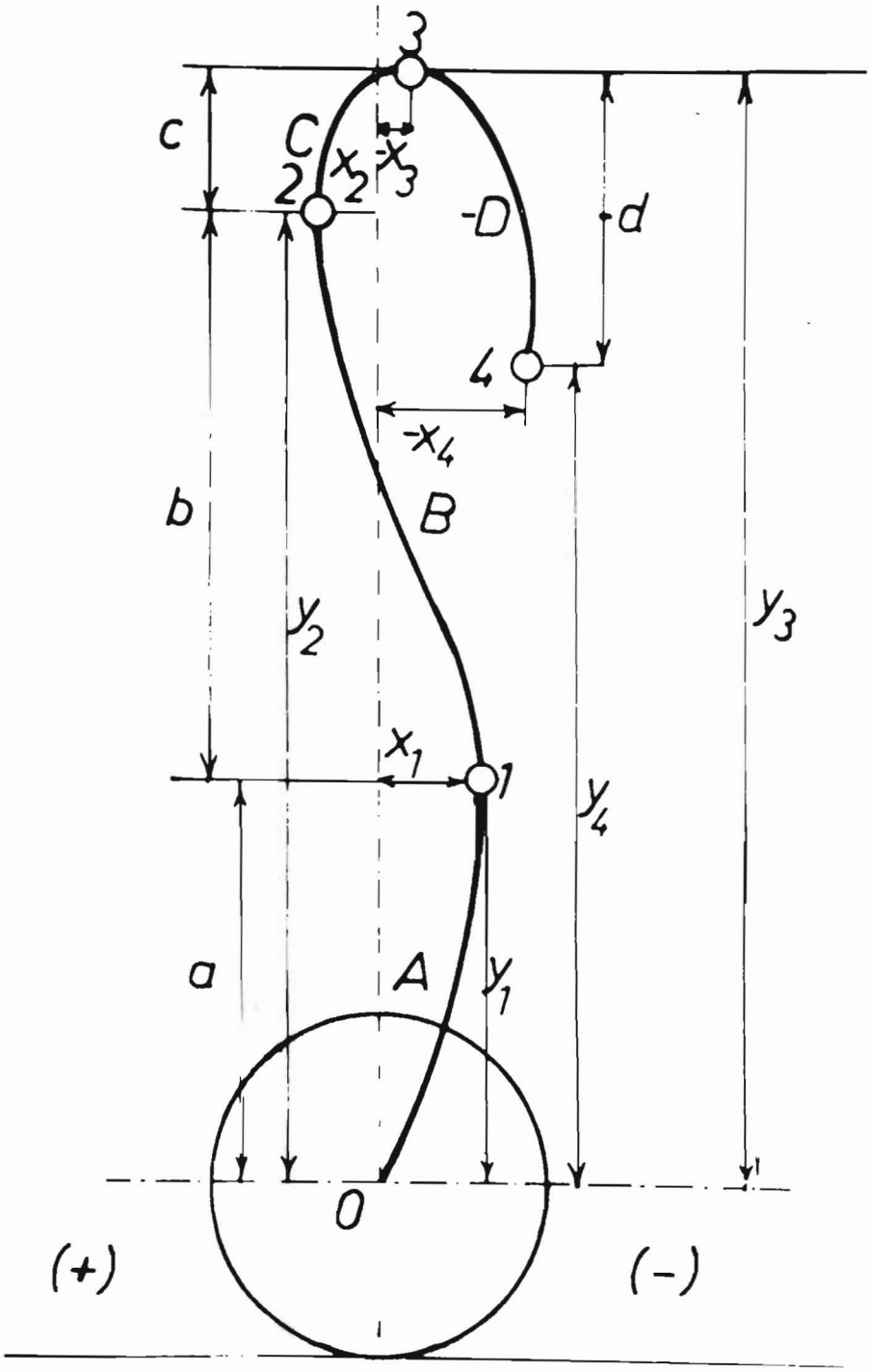


Fig. 2. Stylized motion curve of successful snatch.

We are demonstrating the kinematic parameters established on the basis of a total of 34 successful snatching exercises.

We have carried out a factor analysis of anthropometric, dynamic and kinematic data /85 variables/ (Table 1).

TABLE 1a

Anthropometric data for examined weightlifters

	Variables		Mean	SD	V%
1.	Body weight	(kg)	71,9	10,5	14,6
2.	Stature	(cm)	163,8	9,1	6,0
3.	Lengths Foot	(cm)	23,6	1,7	7,2
4.	Trunk	(cm)	58,6	4,7	8,1
5.	Upperarm	(cm)	28,9	1,8	6,4
6.	Forearm	(cm)	22,9	1,8	7,9
7.	Upper Extremity	(cm)	69,3	6,1	8,9
8.	Thigh	(cm)	47,8	4,9	9,0
9.	Calf	(cm)	34,5	3,7	10.8
10.	Lower extremity	(cm)	88,0	5,0	5,7
	Breadths	(cm)			
11.	Biacromial	(cm)	40,7	1,9	4,8
12.	Bicristal	(cm)	28,2	1,9	6,7
13.	Biocondylar humerus	(cm)	6,3	0,4	5,8
14.	Wrist	(cm)	5,3	0,2	3,3
15.	Bicondylar femur	(cm)	9,4	0,6	6,0
16.	Ankle	(cm)	7,1	0,4	5,4
17.	Foot	(cm)	9,1	0,8	9,1
18.	Hand	(cm)	8,3	0,8	9,1
	Circumferences	(cm)			
19.	Chest	(cm)	96,7	7,1	7,3
20.	Upper arm flexed	(cm)	35,9	2,7	7,6
21.	Upper arm	(cm)	32,0	1,9	6,0
22.	Forearm	(cm)	29,2	1,1	3,7
23.	Wrist	(cm)	17,2	1,0	5,8
24.	Thigh	(cm)	59,3	4,2	7,1
25.	Calf	(cm)	36,3	3,6	9,9
26.	LBM (lean body mass)	(kg)	63,7	8,0	12,6

	Segment weight	(kg)			
27.	Head	(kg)	4,7	0,3	6,1
28.	Trunk	(kg)	28,1	5,8	20,6
29.	Upper arm	(kg)	1,9	0,4	21,1
30.	Forearm	(kg)	1,3	0,2	15,3
31.	Hand	(kg)	0,4	0,1	25,0
32.	Thigh	(kg)	9,0	1,6	17,8
33.	Lower leg	(kg)	3,8	0,6	15,8
34.	Foot	(kg)	1,1	0,1	9,0
35.	Predicted body weight	(kg)	67,8	8,2	12,1

TABLE 1b

Dynamical parameters of successful snathes

	Variables		Mean	SD	V%
36.	Lifted mass	(kg)	98,4	14,9	15,1
37.	t_{F1}	(s)	0,68	0,30	44,1
38.	t_{F2}	(s)	1,07	0,34	31,8
39.	t_{F3}	(s)	0,21	0,06	28,6
40.	t_{F4}	(s)	0,29	0,09	31,0
41.	t_{F5}	(s)	1,03	0,30	29,1
42.	t	(s)	3,11	0,84	27,0
43.	F_1	(N)	1246	138	11,1
44.	F_2	(N)	1447	118	8,2
45.	F_3	(N)	1114	190	17,1
46.	F_4	(N)	1619	180	11,1
47.	F_5	(N)	1710	334	19,5
48.	F_α	(°)	62,1	11,1	17,9
49.	t_{F1}	(%)	21,6	6,8	31,5
50.	t_{F2}	(%)	29,0	11,8	40,7
51.	t_{F3}	(%)	7,4	2,4	22,4
52.	t_{F4}	(%)	9,3	4,8	51,6
53.	t_{F5}	(%)	32,7	4,2	12,8
54.	F_1	(%)	129	28	21,7
55.	F_2	(%)	149	20	13,4
56.	F_3	(%)	114	26	22,8
57.	F_4	(%)	168	39	23,2
58.	F_5	(%)	173	30	17,4

TABLE 1c

Kinematical parameters of successful snathes

	Variables		Mean	SD	V%
59.	(x_1-x_0)	(cm)	9,0	5,0	61,1
60.	(y_1-y_0)	(cm)	68,3	5,1	7,5
61.	(x_2-x_0)	(cm)	0,3	7,1	54,2
62.	(y_2-x_0)	(cm)	109,8	9,5	8,6
63.	(x_3-x_0)	(cm)	0,6	8,9	57,6
64.	(y_3-y_0)	(cm)	125,9	9,2	7,3
65.	(x_4-x_0)	(cm)	15,8	7,8	49,4
66.	(y_4-y_0)	(cm)	105,7	4,4	4,2
67.	$(y_2-y_1)=b$	(cm)	41,5	8,6	20,7
68.	$(y_3-y_2)=c$	(cm)	16,1	5,5	34,2
69.	$(y_3-y_4)=d$	(cm)	20,3	8,0	39,4
70.	(a+b+c+d)	(cm)	146,2	16,6	11,3
71,	a	(%)	47,1	5,4	11,5
72.	b	(%)	28,4	4,3	15,1
73.	c	(%)	11,3	3,8	33,6
74.	d	(%)	13,4	4,3	32,1
75.	(A+B+C+D)	(cm)	163,0	15,2	9,3
76.	(a+b+c+d)	(%)	89,7	3,6	4,0
77.	$t_1(A)$	(ms)	631,0	93,0	15,0
78.	$t_2(B)$	(ms)	220,0	60,0	27,3
79.	$t_3(C)$	(ms)	167,0	26,0	15,6
80.	$t_4(D)$	(ms)	367,0	133,0	36,2
81.	t	(ms)	1384,0	191,0	13,8
82.	$v_1(A)$	(m/s)	1,11	0,16	14,4
83.	$v_2(B)$	(m/s)	1,95	0,32	16,4
84.	$v_3(C)$	(m/s)	0,95	0,21	22,1
85.	$v_4(D)$	(m/s)	0,56	0,16	28,6

During this process altogether 7 main factors were determined. The factors with the greatest eigenvalue (ownvalue) are as follows: (Table 2).

The parameters grouping around the first factor /F_1/ are the time and force parameters of the dynamogram. Therefore the first factor which mostly determines successful snatching exercises is called *dynamic factor*.

TABLE 2

Factors Affecting the Successful Weightlifting Exercises

FACTORS AFFECTING THE SUCCESSFUL WEIGHTLIFTING ECERCISES

VARIABLES OF FACTOR ANALYSIS

VARIABLES	NUMBER OF VARIABLES	
body weight		(1)
lengths	9	(2-10)
widths	8	(11-18)
circumferences	7	(19-25)
LBM	1	(26)
weight of body segments	9	(27-35)
lifted weight	1	(36)
kinematical data	27	(37-63)
dynamical data	22	(64-85)

Factors Affecting the Successful Weightlifting Exercises

Factors	Names of factors	OWN VALUE of factors
F_1	dynamic factor	9,268
F_2	robusticity and muscularity	8,954
F_3	exposivness	7,949
F_4	technical factor (path of motion)	5.383
F_5	active muscle-mass of limbs	4.636
F_6;F_7	partial motion first and second phase	4,363, 4,197

It is a «clean» factor, therefore the variables reflect the volume of exerted power and its execution in time. Based upon its highest eigenvalue, one can rightly suppose that this group of parameters is the most important one in the biomechanical description of the weightlifting exercise.

The second factor /F_2/ contains those components of body shape which refer to the width, «bulkiness» of the limbs and the trunk. We call this

group of variables the *factor of robusticity and muscularity.* This is also a «clean» factor in the sense that it contains only variables /characters of body shape/ of the same nature.

The third group of parameters is dominated primarily by characteristics referring to the duration of forces and to speed relations of the movement. These variables are thus called *factors of explosiveness.*

The next group /F_4/, separated on the basis of eigenvalue, can again be regarded as «clean» since only the kinematic characteristics of the motional curve /for example the length of the full «sitting in», the percentage share of partial movements/ are concentrated here. We gave the name *technical factor* of the motional curve to this group of variables.

The next value /F_5/ again represents, to a great extent, the variables of body shape. The bulky volume of the limbs, the circumferences all refer to the active «stock» of muscles therefore we call this group the *factor of active «stock» of muscles.*

CONCLUSION

On the basis of our examinations we can state that one of the decisive conditions of success is the existence of an adequately great, maximal force. Further, from the point of view of the body shape of the weightlifters, the chances of a more robust, muscular type of athlete are more favourable in achieving better results.

Finally, raw maximal force itself is not sufficient for top results: explosiveness and the speed of carrying out the movement play a more vital role here.

REFERENCES

Clauser, C. E., McConville, J. T. and Young, J. W: Weight, volume and center of mass of segments of human body. AMRL-TR-69-70. Wright-Patterson Air Force Base, Ohio, 1969.

Martin, D. and Saller, K.: Lehrbuch der Anthropologie (1957-1966) Band 3. Gustav Fischer Verlag. Stuttgart, 1966.

Rigler, E. and Eiben, O.: The physique of weightlifters (Third European Congress of Sport Medicine, 1974. Budapest, Vol.: III, 847-852. p.).