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Obesity and metabolic disorders in adults with lower limb amputation

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Abstract—Anthropometric and biochemical research was conducted on 94 subjects with various levels of lower limb amputation. The purpose of the work was to investigate the features of obesity progression and disorders of cholesterin metabolism, as well as to develop adequate training exercises. Anthropometric research was conducted by calipermetry; the biochemical research was done by various methods to determine exempt and total cholesterin and triglycerides in the blood serum.

The research establishes the frequency of obesity progression relative to the level of amputation, as well as the features of the excessive body mass. Type 11A hyperlipoproteidemia was evident. It is characterized by rapid progress of atherosclerotic vascular disease and coronary disease (CD). Cyclic and acyclic exercises were developed for prophylaxis and therapy.

Anthropometric research on the determination of body fat mass was conducted on 68 subjects with various levels of lower limb amputation. The nondirect method of measuring skin folds of several parts of the body was used to determine the extent of lipogenesis. Biochemical research of cholesterin metabolism was conducted on 26 subjects with lower limb amputation (a different group).

Anthropometric research revealed an increase of body fat mass directly related to the level of amputation. The largest amount of fat in the body mass was noted for the subjects with bilateral transfemoral (above-knee) amputation or transfemoral plus transtibial (below-knee) amputation. Both groups averaged 25.9%. The body fat mass increased chiefly in the subcutaneous fat. Increase of the internal fat mass was less noticeable. The frequency of obesity progression in subjects with unilateral transtibial amputation equaled 37.9%; in subjects with transfemoral amputation, 48.0%; and in subjects with bilateral transfemoral or transfemoral plus transtibial amputation, 64.2%. Young subjects demonstrated obesity progression during the first year after amputation.

Biochemical research revealed changes in the cholesterin fractions typical for type 11A hyperlipoproteidemia. This type of hyperlipoproteidemia is often accompanied by atherosclerotic vascular diseases and CD.

On the basis of the research and clinical observation, exercises were developed aimed at prophylaxis and treatment of the revealed changes. Exercises are described for subjects with various levels of lower limb amputation when using exercise machines and when swimming.

Key words: *adults with lower limb amputation, exercise equipment, exercising, increase of subcutaneous fat, lipid metabolism disorders, obesity, swimming, type 11A hyperlipoproteidemia.*

INTRODUCTION

The efficiency of combined restorative treatment and medical social rehabilitation in adults with lower limb amputation is mainly determined by the functional ability of the basic life-providing systems of the organism and the state of metabolic processes (1–4).

Clinical observations prove that obesity occurs in many subjects after amputation. Their body weight becomes almost the same, or even the same, as before the amputation. Excess body mass decreases the locomotor feasibility and hinders retention of prosthetic fit.

Some authors state that amputation and prosthetic use are factors that cause progression of coronary disease (5–7). Kaznacheev (8) noted that coronary

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disease (CD) in adults with lower limb amputation becomes more harmful than in patients who do not have amputation. This conclusion is based on a correlation of essential disorders of the lipid metabolism during a physical load in subjects with amputation and those who have CD. Obesity reduces energy and hinders the cholesterin etherification processes. The results indicate deterioration of metabolism. The most probable cause of the disorders was the exhaustion of reserves of high, nonsaturated acids that are considered an unfavorable metabolic adaptation to physical load. These data were correlated with frequently observed CD.

The problem of lipid metabolism is influenced not only by the presence of metabolic disorders but also by the fact that they are manifested with other factors of risk: hypokinesis, hemodynamic disorders, and obesity.

The purpose of this study was to study the features of obesity in adults with lower limb amputation and the disorders of cholesterin metabolism, as well as to develop aids for exercise training.

METHODS AND MATERIAL

Anthropometric Research

Nondirect determination of body fat mass was conducted in 68 male subjects with lower limb amputation. Subjects aged 20–49 years were examined (30 subjects, 44.1 percent, aged 20–29 years; 16 subjects, 23.5 percent, aged 30–39 years; and 22 subjects, 32.4 percent, aged 40–49 years). Lower limb amputation sites were: 30 subjects with transtibial, 25 with transfemoral, 7 with bilateral transtibial + transfemoral, and 6 with bilateral transfemoral.

Various etiologies caused amputation. Distribution of the subjects by cause of amputation is given in **Table 1.**

The young and middle-aged subjects had postamputation periods of from 4 to 6 months (7 subjects); 6–12 months (12 subjects); 1–5 years (36 subjects); 5–10 years (7 subjects); and over 10 years (6 subjects).

Most subjects were examined long after amputation and thus had already adapted to changed homeostasis. Forty-three subjects in the postamputation period used prostheses and 25 did not.

Anthropometric measurements were compared with those of a nondisabled control group, which consisted of 12 males of similar age who did not suffer from any internal diseases. The indexes of body fat mass from the control group were similar to published data (9).

Table 1.
Distribution of subjects by cause of amputation.

Cause of Amputation	Number	Percent
Car accident	17	25.0
Railway accident	15	22.1
Mechanical (industrial) trauma	11	16.2
Vessel obliteration disease	10	14.7
Mine-explosion wounds	3	4.4
Chronic osteomyelitis	3	4.4
Firearm wound	2	2.9
Burns	2	2.9
Thrombosis	1	1.5
Malignant tumors	1	1.5
Other trauma	3	4.4
Total	68	100.0

The nondirect method of measuring skin folds on various parts of the body was used to characterize the degree of lipogenesis. For measuring skin folds, we used a caliper with the constant pressure equal to 10 g/mm^2 and the area of contact surfaces equal to 90 mm^2. The following folds were measured: rear shoulder, front shoulder, back (under the lower angle of the scapula), anterior forearm, on the breast, abdomen, hip, shin, and the dorsal hand—at the level of the third finger (10). Determination of the absolute quantity of fat component in the body mass (D) was carried out by the Matiegka and Behnke Method (11). The average thickness of the subcutaneous fat, together with the skin (d), was calculated by the method described by Lutovinova et al. (12). The skin fold on the shin could not be measured in subjects with bilateral transfemoral and transfemoral + transtibial amputation. The following indexes were calculated: subcutaneous fat mass (D1), by the methods described by Martirosov (10); the unregistrated fat residue (D2), which is considered by Lutovinova et al. (13) as the internal fat, and was determined as the difference of all fat in the body mass and the subcutaneous fat mass; the fat percentage in the body mass (%); correlation of the absolute fat contents, and subcutaneous fat relative to the reduced body surface. Determination of the body surface area was carried out by the method described by Kondrashin (14).

Biochemical Research

Measurement of cholesterin metabolism was done in 26 subjects with lower limb amputation: 12 with transtibial, 46.1 percent; 12 with transfemoral, 46.1 percent; and 2 with bilateral transfemoral, 7.8 percent.

Their ages varied from 19 to 45 years. The causes of amputation are given in **Table 2.** The time after amputation was from 6 months to 10 years (4.8 years average). Eight clients came to the clinic for initial prostheses, 18 used their prostheses prior to this study. Results were compared with those of the control group, which consisted of 20 nondisabled males of the same age.

For chemical and biochemical tests, we used direct determination of free and total cholesterin (CH) in the blood serum (15) based on the interaction reaction of a colored reagent with CH of the same sample in various temperature conditions. This method includes two stages: 1) determine the amount of free CH and 2) determine the amount of free and linked CH.

The coefficient of etherification (K et) was calculated as the ratio between total CH and ether-linked CH.

Determination of total CH was also carried out by the Ilk method (15) based on the fact that CH becomes green if one uses acetic anhydrate and the mixture of acetic and sulfuric acids (Liberman-Burhard reaction).

We also identified triglycerides (TG). This method is based on the soaping of TG by potassium hydrate, thus forming glycerin. The reagent containing acetylaceton interacts with formaldehyde forming 3,5-diacetyl-1,4-dihydrolutadin, in which hue intensity is determined photometrically (16).

We calculated the amount of cholesterin in lipoproteins of very low density (CH-LPVLD), as well as CH of lipoproteins of low density (CH-LPLD). Determination of CH in a-lipoproteins (CH-LPHD) was based on precipitation of the fractions b- and pre b-lipoproteins by heparin; manganese ions being present. Meanwhile, a-lipoproteins remained in the supernatant in which we determined the contents of CH. We calculated the coefficients of atherogenesis (K ether), which was determined by the ratio of total CH and CH-LPHD relative to CH-LPHD.

Table 2.
Distribution of the subjects by cause of amputation.

Cause of Amputation	Number	Percent
Car accident	6	23.1
Railway accident	5	19.2
Industrial trauma	5	19.2
Vessel obliteration disease	4	15.4
Mine-explosion wounds	2	7.7
Other trauma	4	15.4
Total	26	100.0

Statistical processing of the data was done by analysis of variance (ANOVA) and of correlation-regression analysis, calculating the correlation coefficient (R x/y), the correlation coefficient error (m r), and the regression coefficient (B y/x). Validity of the correlation coefficients was checked by z-transformation.

RESULTS AND DISCUSSION

Results of Anthropometric Research

Data comparing the change of body fat mass in the subjects and the control group are given in **Table 3.** Decrease of body mass was typical only for the subjects with bilateral lower limb amputation. The fat component of the body mass increased for subjects with amputation as compared with the control group. The largest amount of fat in the body mass (25.9 percent) was noted for subjects with bilateral lower limb amputation. The absolute amount of fat component in subjects with transtibial amputation exceeded the similar index of the control group by 54.7 percent; in subjects with transfemoral amputation by 80.2 percent; and in subjects with bilateral lower limb amputation by 79.5 percent. Although subjects with transfemoral amputation and those with bilateral lower limb amputation had practically the same absolute amount of fat, the fat percentage in the body mass of the latter was higher. The fat component increased both at the expense of the subcutaneous fat mass, which exceeded the control value by 75.7 percent for the subjects with transtibial amputation, by 114.6 percent for those with transfemoral amputation, and by 132.7 percent for subjects with bilateral lower limb amputation, and the internal fat mass, which exceeded the control value by 45.4 percent, 61.8 percent, and 65.6 percent, respectively.

Thus, one may conclude that the fat component of the body mass was chiefly increased by subcutaneous fat. This conclusion was confirmed by the analysis of relative indexes—correlation of fat mass and hypodermic fat with respect to the reduced area of the body surface. Thus, the ratio of the fat mass and body surface increased as compared with the control group as follows: 73.6 percent in subjects with transtibial amputation, 106.1 percent in those with transfemoral amputation, and 139.4 percent in subjects with bilateral lower limb amputation. At the same time, the ratio of subcutaneous fat and the area of the body surface increased by 75.0 percent, 113.2 percent, and 182.9

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Table 3.
Change of body fat mass in adults with lower limb amputation (M ± m).

Indexes	Unit of Measure	Control Group (n=12)	BK Amp (n=30)	P 3–4	AK Amp (n=25)	P 3–6	Bilat AK Amp AK + BK Amp (n=13)	P 3–8
1	2	3	4	5	6	7	8	9
Body mass	kg	73.7 ± 2.0	70.8 ± 2.6		71.6 ± 3.2		64.7 ± 3.1	<0.05
Av thickness of HF w/skin	mm	3.96 ± 0.39	6.52 ± 0.63	<0.01	7.78 ± 0.76	<0.01	8.50 ± 1.26	<0.01
Abs amount of fat (D)	kg	9.73 ± 1.02	15.05 ± 1.63	<0.05	15.53 ± 1.99	<0.01	17.47 ± 2.60	<0.02
HFM (D1)	kg	4.65 ± 0.64	8.17 ± 1.14	<0.05	9.98 ± 1.29	<0.01	10.82 ± 1.70	<0.01
Fat content in body mass	%	12.52 ± 1.29	21.06 ± 1.78	<0.01	22.94 ± 2.04	<0.01	25.91 ± 1.47	<0.001
Internal fat mass (D2)	kg	4.56 ± 0.38	6.63 ± 0.56	<0.02	7.38 ± 0.72	<0.01	7.55 ± 0.89	<0.02
D/S body	kg/m^2	4.88 ± 0.52	8.47 ± 0.81	<0.01	10.06 ± 1.01	<0.01	11.71 ± 1.63	<0.01
D 1/S body	kg/m^2	2.58 ± 0.32	4.54 ± 0.56	<0.02	5.76 ± 0.67	<0.01	7.30 ± 1.10	<0.01

Abs = absolute; AK = above-knee; BK = below-knee; Amp = amputation; Av = average; Bilat = bilateral; HF = hypodermic fat; HFM = hypodermic fat mass; S body = area of body surface, m^2.

percent (P<0.05 in all groups), respectively. The degree of increasing the ratio of internal fat and the area of body surface was much less.

It is important to note that obesity was detected in 37.9 percent of subjects with transtibial amputation, in 48.0 percent of subjects with transfemoral amputation, and in 64.2 percent of subjects with bilateral lower limb amputation. Thus, the frequency of the above pathology directly depends upon the level of amputation.

Fourteen men who came for initial prostheses and 18 who had used prostheses for a long time were among the subjects with noticeable clinical signs of obesity. Thus, obesity progression did not depend on such an important factor as the use of prostheses. Evidently, the causes of obesity progression refer equally to all patients, and physical load conditioned by walking on prostheses does not essentially affect the process of lipogenesis.

Table 4 gives the correlation coefficients reflecting interdependence between the basic indexes analyzed both for the patients and the control group. Correlations testify that the body mass of nonamputees is minimally conditioned by the fat component. Evidently, muscular mass and bone tissue play a significant part in fat formation; the correlation between body mass and subcutaneous and internal fat is weak. At the same time, the correlation between subcutaneous and internal fat is characterized by a high degree of interdependence.

Dependence of body mass upon the fat component constantly increased for the subjects with amputation. Approximately the same dependence upon the subcutaneous and internal fat exists. Thus after amputation, the total body mass, to a significant extent, is conditioned by fat tissue while muscular and bone tissues are reduced. At the same time, when obesity progresses, specific interdependence of the reduced area of the body surface and fat mass increases. **Figure 1** shows the regression curves reflecting interdependence between the body surface area and body fat mass. One can distinguish the essential difference between the control group and subjects with amputation. First, if the fat tissue was the same, surface area in those with amputation reduced directly depending on the amputation level, and secondly, obesity progression was accompanied by a noticeable relative enlargement of the body surface area. Neither of these changes occurred in the control group. In our opinion, this regularity is important for the anthropometric estimation of the state

Table 4.
Correlation dependence among anthropometric indexes (Rx/y ± m r).

Analyzed Intercon y = f (x)	Control Group (n=12)	BK Amp (n=30)	P 2–3	AK Amp (n=25)	P 2–5	Bilat AK Amp AK+BK Amp (n=13)	P 2–7
1	2	3	4	5	6	7	8
Weight=f (M body)	0.275 ± 0.304	* 0.395 ± 0.174		* 0.466 ± 0.184		* 0.631 ± 0.233	
M body = f (D)	0.455 ± 0.283	** 0.677 ± 0.139		*** 0.824 ± 0.118		** 0.767 ± 0.139	
M body = f (D1)	0.371 ± 0.293	*** 0.678 ± 0.139		*** 0.807 ± 0.123		** 0.746 ± 0.201	
M body = f (D2)	0.487 ± 0.276	*** 0.781 ± 0.118		*** 0.835 ± 0.114		*** 0.791 ± 0.184	
D1 = f (D2)	*** 0.930 ± 0.116	*** 0.956 ± 0.055		*** 0.962 ± 0.057		*** 0.968 ± 0.076	
M body = f (S body)	*** 0.843 ± 0.170	*** 0.892 ± 0.085		*** 0.871 ± 0.102		*** 0.864 ± 0.151	
D = f (S body)	0.103 ± 0.314	*** 0.892 ± 0.085	<0.01	*** 0.730 ± 0.142	<0.05	* 0.628 ± 0.235	
D1 = f (S body)	0.016 ± 0.306	* 0.499 ± 0.163		*** 0.703 ± 0.148		* 0.613 ± 0.238	

AK = above-knee; BK = below-knee; Amp = amputation; Bilat = bilateral; Intercon = interconnections; S body = body surface area, m^2. * = Rx/y<0.05; ** = Rx/y<0.01; *** = Rx/y<0.001.

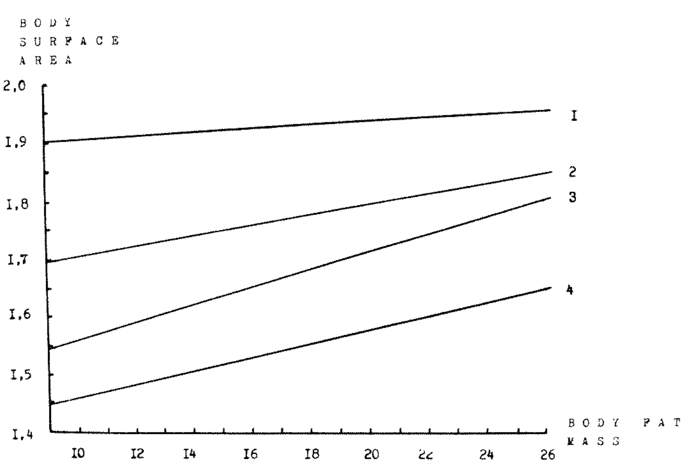

Figure 1.
Regression dependence between body fat mass and body surface area. 1 = control group; 2 = transtibial amputation; 3 = transfemoral amputation; 4 = bilateral amputation.

of the organism after amputation of the lower limbs. Under conditions of changing normal height and weight proportions of the human being, the lipogenesis process formed in the remaining part of the body is accompanied by actual enlargement of the body surface area by weight, but (obviously) not by height.

Close correlation between body mass and body surface area and between the subcutaneous fat mass and internal fat remains both for subjects with amputation and the control group. Anthropometric research confirms progression of the metabolic disorder due to amputation of the lower limbs. It is important to note that obesity progresses in young patients. We did not find a correlation of obesity progression depending upon the cause of amputation, although clinical observation suggests that the excessive body mass was formed during the first year after amputation.

Thus, obesity progresses chiefly because the subcutaneous fat increases after amputation of the lower limbs directly depending on the amputation level. Accumulation of the subcutaneous fat is accompanied by enlargement of the skin surface area. The fat component mass reaches the maximum value after high bilateral amputation in subjects who experience the most noticeable limitation of physical activity. This fact allows one to consider hypokinesia as one of the main causes of obesity.

In our opinion, overeating has a certain amount of importance, besides limitation of activity, as an etiology of obesity. It is possible to form excessive body mass if activity is limited and the food intake contains too many calories (17). Some authors (18,19) posit that inactivity is characterized by a low level of energy. Intensive physical training (e.g., 40–50 km run per week during 16–18 weeks) leads to decrease of the total mass, subcutaneous fat, and increase of "lean" body mass. Food consumption was slightly increased. The authors emphasized that due to the reduction of the food intake, body mass decreased but afterward it returned to the previous value. Thus, it is necessary to perform physical exercise consistently in order to prevent inactivity. The most efficient method was a combination of advanced physical activity and a decrease in caloric intake.

Reduced activity is typical for subjects with lower limb amputation (especially bilateral amputation) while preparing for prostheses because they maintain a very sedentary life, or sometimes move about in a wheelchair. During this period, the excessive fat mass of the body is formed. In this respect, reduction of the time required for preparation and initial fitting of prostheses is an important factor in the prevention of obesity. Limitation of caloric consumption and proper use of adequate exercise are also important factors during this period.

Results of Biochemical Research

Preliminary analysis of investigating cholesterin metabolism relative to the amputation level did not reveal essential differences among the groups. The contents of various cholesterin fractions in the blood serum are given in **Table 5.** The estimation of the results was carried out in all of the research.

Total cholesterin of the subjects with amputation increased by 175.5 percent as compared with the control group. The contents of cholesterin ethers did not change appreciably, but K et decreased by 18.6 percent. A considerable increase (243.3 percent) was found in CH-LPLD. However, CH-LPHD slightly decreased, which caused the increase of K ater by 89.7 percent. As to triglycerides, no essential changes were found.

Changes of cholesterin fractions are typical for Type 11A hyperlipoproteidemia, which often causes atherosclerosis of vessels and CD. Gasilin and Kurdanov (20) state that the increase of K ater in patients who suffer from atherosclerosis (with or without hyperlipoproteidemia) testifies to the connection of coronary atherosclerosis with transportation of cholesterin into the vessel wall, and it prevails over the system of cholesterin removal. Thus, the data reveal important aspects of the change in metabolic process and explain the fact of CD progression after amputation of the lower limbs not only in case of the vessel obliteration disease but also after traumatic amputation.

Table 5.
Contents of various cholesterin fractions in bload serum (M ± m).

Indexes	Unit of Measure	Control group (n = 20)	Subjects with Amputation (n = 26)	P 3–4
1	2	3	4	5
CH total	mmol/L	3.50 ± 0.31	3.91 ± 0.96	
CH ether	mmol/L	2.74 ± 0.36	2.45 ± 0.10	
CH free	mmol/L	0.53 ± 0.08	1.46 ± 0.07	<0.001
K et	%	76.75 ± 2.02	62.54 ± 1.33	<0.001
CH-LPHD	mmol/L	1.41 ± 0.16	1.34 ± 0.13	
CH-LPLD	mmol/L	1.27 ± 0.16	4.36 ± 0.42	<0.001
CH-LPVLD	mmol/L	0.88 ± 0.20	0.73 ± 0.09	
TG	mmol/L	1.93 ± 0.27	1.71 ± 0.21	
K ater	%	2.53 ± 0.58	4.80 ± 0.63	<0.05

It is important to note that amputation of the limb, and the unfavorable aftereffects, negatively influence cholesterin metabolism in a way that results in atherosclerosis. Evidently, hyperlipoproteidemia combined with inactivity, overeating, and hemodynamic disorders is the basic pathogenetic mechanism for the progression of myocardial atherosclerosis and CD. In this respect, one can make an important conclusion that it is necessary to increase physical activity for prophylaxis of coronary disease. Many authors postulate that activity is the major anti-risk factor for CD progression (21–23). For example, Motylianskaya et al. (22) state that on the basis of systematization of the risk factors for atherosclerosis and its aftereffects, one can differentiate among genetic factors, external reasons, and such conditions that cause and intensify their effect. Inactivity, as well as hemodynamic disorders (hypertension in particular), play a very important part. One of the most vital means of prophylaxis of atherosclerosis is to change inactivity to an active way of life. The favorable effect of activity on retarding the progression of atherosclerosis has been demonstrated by many investigators. In particular, the state of lipid metabolism for persons who do physical exercises differs from that of inactive persons; total cholesterin and b-fractions lipoproteins especially decreased, and a-fractions and keton substances in blood increased.

Exercise

It is known that normalization of lipid metabolism and decrease of cholesterin in blood are possible when the patient does aerobic cyclic exercises that oxidize free acids and are accompanied by the increase of endurance and the level of maximal oxygen intake (MOI). Acyclic exercises, in which the structure of movements has no stereotyped cycle and changes while they are done, chiefly affect function of the locomotor system. As a result, the muscle force, reaction quickness, mobility of vessels, and lability of the neuromuscular system are increased (24). Therefore, it is necessary to do both cyclic and acyclic exercises, the former being preferable.

A set of exercise equipment that provides exercise of the muscles of upper and lower limbs, back, and abdomen are used for cyclic aerobics. The set consists of 17 devices providing the exercise of separate groups of muscles. After bilateral lower limb amputation subjects use the following exercise equipment: 1) a rowing machine (for exercising the latissimus dorsi and deltoideus part posterior); 2) specific equipment for exercising the latissimus dorsi; 3) equipment for exercising the shoulder girdle muscles, deltoideus part anterior, and pectoralis major); 4) beams (such as those used in gymnastics) for the muscles of the back and abdomen; 5) equipment for strengthening the biceps; and 6) an expander, with loading (for shoulder and forearm muscles). Subjects with unilateral lower limb amputation use the equipment to condition their femoris muscles and the leg muscles of their intact limb. This method is suitable for conditioning the groups of surviving muscles.

The optimum movement mode was selected considering the level of amputation and physical status that enabled an achievement of positive results to improve the status of the cardiovascular system and increase work capacity.

Exercising was conducted in groups of 4–6 men, for a 40–60-minute session, every day for one month. The groups of patients with amputation were selected with approximately similar levels of amputation and physical state to facilitate medical control. We used the ''circular'' method (i.e., the patients were able to move from one exercise device to the next). The time of the exercise on each device was from 3 to 5 minutes, with rest intervals of from 2 to 4 minutes.

For those who were just starting their training, the initial loads were 6.4–19.2 kg (selected by the level of amputation and clinical and physical state). Later, the load was increased to 19.2–32.0 kg.

We used swimming as an exercise in parallel with the exercise equipment. Three times a week, the subjects had 40-minute sessions in the swimming pool. They were trained to crawl, dive, and play with a ball. We worked out special methods for swimming that included exercises on land and in the water. All of the subjects had obesity of varying degrees. We observed the group of 15 subjects with amputation who did exercises on the exercise equipment for one month and noticed their tendency (not statistically significant) to lessen their body fat mass. It is important to note that the most noticeable changes of body mass were in subjects with transtibial or transfemoral amputation (within 5.0–7.0 percent). In subjects with bilateral lower limb amputation, the change was minimal.

Our results correspond to the data reported by Pitetti et al., who noted the decrease in body mass in only 3 out of 10 subjects with lower limb amputation who had a 15-week exercise training program (25).

We observed a group of 30 teenagers from 14 to 16 years of age who had swimming exercise for one month. Anthropological and biochemical studies have not revealed any essential change in body fat mass or in cholesterin metabolism indicators in the subjects examined.

Different types of acyclic exercises were developed for subjects with transtibial, transfemoral, and bilateral amputation. The duration of each exercise was from 30 to 40 minutes, 5 times per week. The exercises stressed all muscle groups and were aimed at increasing vessel mobility and balance training.

As a result of one month of exercise, all patients stated they felt better and had increased activity.

Thus, for subjects with lower limb amputation, systematic exercise had positive effects on the organism despite the absence of statistically significant data about change of body fat mass and cholesterin metabolism.

CONCLUSION

Anthropometric and biochemical research revealed changes in body fat mass and cholesterin metabolism in subjects with lower limb amputation. The progression of obesity directly depends on the level of amputation and the degree of activity decrease and nutritional increase. The increase of body fat mass took place mainly at the expense of subcutaneous fat. There was a specific correlational relation between the reduced surface area of the body and fat mass. The use of prostheses and the physical load associated with it do not essentially influence lypogenesis.

The change in lipid metabolism is typical for all patients with amputation. Type 11A hyperlipoproteidemia has a high correlation with CD, which explains why CD often progresses after amputation.

The program of exercise, including cyclic and acyclic exercises of aerobic character (mainly cyclic), does not result in an essential change of body mass and cholesterin metabolism in a one-month session. Therefore, the performance of physical exercise and the reduction of food intake should be systematic and continuous. Together with other methods of treatment, early prosthetic use is aimed at achieving the most complete medical and social rehabilitation of subjects with lower limb amputation.

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