towards the design and implementation of some learning situations aimed at training students in the skills specific to the field; to express their didactic creativity in adjusting the teaching approaches to the peculiarities of the students they are working with; the use of preferred learning techniques depending upon the personality traits, the learning style; using some active methods that can help developing receptivity and the ability of rational approach to economic, personal and public problems, in the context of a complex and dynamic economic, social and cultural environment, organizing workshops on topics regarding entrepreneurship, the establishment of START-UP, interviews with entrepreneurs and visits to business centres and companies set up by young entrepreneurs, the participation in projects and social and commercial entrepreneurial competitions etc.

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DETERMINATION OF METABOREFLEX WITH THE INNOVATIVE DUMBBELL-FLEXOR SYSTEM

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Abstract
The study started from the hypothesis that the exercises performed with the innovative dumbbell-flexor device applying for less the cardiovascular system than forearm flexion made with ordinary dumbbell (even with much lower resistance), due to lower isometric component of muscle contraction. Evaluation of heart rate and blood pressure in 13 healthy volunteers showed that the hypothesis is confirmed for the first physiological constants. Applications could be the use of the device for kinetotherapy of hypertension and arteriopathies.

Keywords: isometric component, heart rate

1. Introduction

Recovering of the hand in post-stroke paresis through isometric exercises constitutes a basic mean [2, 4]. Although short-term isometric exercise have the effect of reducing blood pressure in hypertensive patients [8], recent research has shown that in normal subjects during the execution of exercises with an important isometric component, metaboreflex cause climbs of arterial blood pressure above the upper limit of normal and corresponding increase in heart rate [3]. As a result, since hypertension is a major etiologic factor for stroke [7], the risk exists that through hand function recovery programs to be favored relapse of the disease. Therefore, in this study we aimed the evaluation of metaboreflex occurred during exercises with an innovative dumbbell-flexor system [5]; one of its features is the reduction of the isometric component of auxotonic contraction necessary for execution. The capacity of the the dumbbell-flexor to reduce isometric component is proved by a recent study on the analgesic effects of this device [6].

2. Materials and methods

The study was conducted on 13 healthy volunteers, normotensive and normal weight (or athletic corpulence). Determining heart rate and blood pressure by invasive methods is viewed with suspicion by volunteers. For this reason, after the model of metaboreflex assessment by isometric handgrip and post exercise ischemia performed using inflatable sleeve which carries a pressure of 240 mm Hg in the active muscle [3], we developed an own protocol using an ordinary dumbbell, a dumbbell flexor system (fig. 1) and an automatic blood pressure monitor (Visomat). On 7 subjects (untrained) was determined blood pressure and heart rate before and immediately after they are executed 20 forearm flexion with a dumbbell loaded to a maximum of 5 kg; the tensiometer sleeve was applied to the active arm.

The same protocol was used for the other arm, after standing for 3 minutes, the subject executing forearm curls with dumbbell-flexor device (the dumbbell loaded to a maximum of 5 kg being raised simultaneously with tightening the flexor calibrated to maximum 10 kgf) (fig. 2). Another 6 trained subjects (members of the volleyball team Penicillina - Iaşi), in a preliminary study, were performed the same exercises, except that the sleeve tensiometer was applied to arm the device idle and triggered 15 seconds before the end of the exercise. The heart rate was measured simultaneously with a digital pulse oximeter, and as reference was previously determined heart rate and blood pressure. The results were analyzed with ANOVA Sigle Factor.

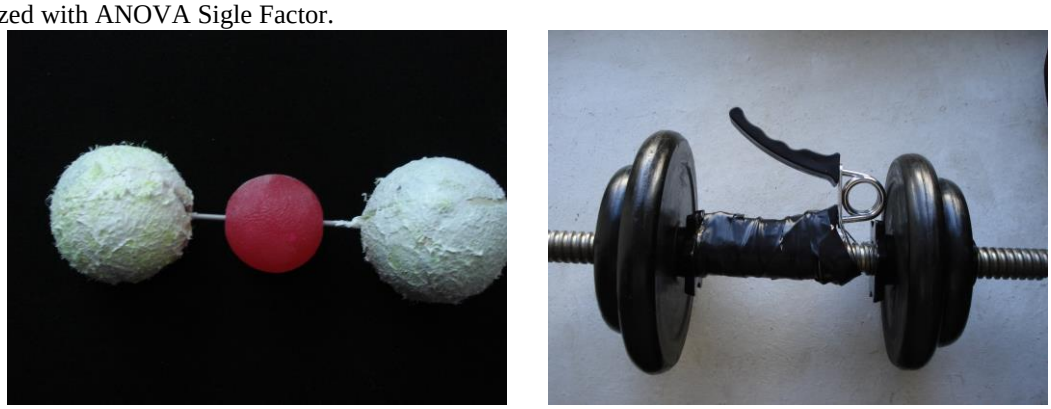

Fig. 1. Dumbbell-flexor types: for recovery (left) and for strength training (right).

Fig. 2. Tensiometer sleeve applied heterolateral (left) and homolateral (right) to the arm that perform the exercise.

3. Results

Anthropometric data, gender, age and blood pressure of subjects participating in the study in which blood pressure was determined at arm heterolateral of which were executed exercises are summarized in table 1.

Table 1. Gender, age, height, weight, systolic blood pressure (SBP) and diastolic blood pressure (DBP) for subjects to which cardiac physiological constants have been determined at heterolateral arm.

Nr. crt.	Gender	Age (years)	Height (cm)	Weight (kg)	SBP (mm Hg)	DBP (mm Hg)
1	F	25	190	77	127	85
2	F	20	181	77	127	79
3	F	25	175	68	128	73
4	F	21	182	70	114	55
5	F	21	177	65	126	70
6	F	27	176	68	128	76

Initial heart rate and those recorded at the end of execution of forearm curls with dumbbells and dumbbell-flexor system (tensiometer sleeve applied to the heterolateral arm) are summarized in table 2.

Table 2. Initial heart rate (HR) and during forearm flexions when tensiometer sleeve was applied to the heterolateral arm.

Nr. crt.	Initial HR (beats/min)	HR during flexions with dumbbell (beats/min)	HR during flexions with dumbbell-flexor (beats/min)
1	77	103	85
2	88	132	85
3	74	128	101

4	70	67	71
5	79	142	73
6	76	130	87
Average and standard error	77,33±6,05	117,00±27,69	83,66±10,85
p	0,0029		

Table 3 shows the gender, age and anthropometric characteristics of the subjects included in the study of metaboreflex caused at the arm in which it is determined the blood pressure.

Table 3. Gender, age, height and weight of the subjects.

Nr.crt.	Gender	Age (years)	Height (cm)	Weight (kg)
1	M	45	177	80
2	M	30	179	86
3	M	20	1,79	82
4	F	20	1,70	59
5	F	20	160	54
6	M	21	188	92
7	F	22	168	60

Table 4 shows the diastolic blood pressures determined at the left and the right arm for subjects participating in the study in witch tensiometer sleeve was mounted on same arm with which they were executed forearm flexions, as well as their variations after exercises performed with dumbbells and dumbbell-flexor.

Table 4. Changes in diastolic blood pressure (DBP) for exercises performed with dumbbells and dumbbell-flexor system respectively.

Nr. crt.	DBP (mm Hg) left arm	DBP (mm Hg) after flexions with dumbbell	DBP (mm Hg) right arm	DBP (mm Hg) after flexions with dumbbell-flexor
1	84	89	84	93
2	70	78	72	136
3	73	85	73	94
4	67	70	62	70
5	74	67	73	78
6	81	88	78	91
7	70	71	73	71
Average and standard error	74,14±6,20	78,28±9,16	73,57±6,65	90,42±22,53
p	0,079			

Table 5 shows the systolic blood pressures determined at the left and the right arm for subjects participating in the study in witch tensiometer sleeve was mounted on same arm with which they were executed forearm flexions, as well as their variations after exercises performed with dumbbells and dumbbell-flexor.

Table 5. Changes in systolic blood pressure (SBP) for exercises performed with dumbbells and dumbbell-flexor system respectively.

Nr. crt.	SBP (mm Hg) left arm	SBP (mm Hg) after flexions with dumbbell	SBP (mm Hg) right arm	DBP (mm Hg) after flexions with dumbbell-flexor
1	129	128	123	132
2	132	129	140	160
3	135	142	137	146
4	119	120	109	122
5	112	106	117	128
6	136	122	125	132
7	132	126	122	134
Average and	127,85±8,97	124,71±10,87	124,71±10,81	136,28±12,72

standard error				
p	0,18			

Table 6 contains the initial heart rates and the ones after execution of forearm curls with dumbbell and dumbbell-flexor system respectively.

Table 6. Initial heart rate and the ones after execution of forearm flexions with dumbbell and dumbbell-flexor system respectively

Nr. crt.	HR left arm (beats/min)	HR after dumbbell curls (beats/min)	HR right arm (beats/min)	HR after dumbbell-flexor curls (beats/min)
1	72	75	72	73
2	80	93	83	89
3	87	98	89	80
4	83	89	73	87
5	69	75	69	68
6	71	71	75	75
7	91	96	91	93
Average and standard error	79,00±8,54	85,28±11,29	78,85±8,76	80,71±9,25
p	0,56			

4. Discussions

Analysis of table 2 shows that heart rate increases significantly (p = 0.0029) when forearm flexions where executed with dumbbell compared with the same exercise performed with dumbbell-flexor, even if in the first case the resistance is approximately 5 kg and 15 kgf in the second. The results in are partially confirms in table 6, even if the differences are not statistically significant (p=0,56). The explanation could be that tightening the flexor during lifting the dumbbell and relaxation of the hand during negative movement fluidizes movement, reducing isometric component of auxotonic contraction. As a result, the metaboreflex is weaker expressed, knowing that isometric contraction plays an important role in its production [3]. In fact, the metaboreflex may increase or decrease muscle blood flow depending on how it is caused [1]. The fact that when using the dumbbell-flexor has not occurred locally occlusion of blood circulation is confirmed by less fatigue reported by the subjects who carried out exercises with the device, even if the resistance was 3 times higher than when using conventional dumbbell. Raising above the upper limit of heart rate in trained subjects could be because their heart is more sensitive to adrenaline. The results are all the more remarkable as recent research has shown that isometric flexion of the fingers have no effect on heart rate and the rhythmic causes its growth [9].

5. Conclusions

1. In healthy subjects, exercises performed with dumbbell-flexor device causes an increase in heart rate at lower magnitude compared to similar exercises performed with dumbbell, even at higher resistance.
2. This fact is due to the decrease of isometric component and blood pumping in arm muscles.
3. Applications may include the use of dumbbell-flexor in physical therapy of arterial hypertension and upper limb arteriopathies.

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