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Normative value for the unsupported upper limb exercise test in asymptomatic individuals: A cross-sectional study

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ABSTRACT

Objective: Thestudy aimed to provide normative value for the unsupported upper limb exercise testas a baseline data for comparison with disease subjects. **Design:** A cross –sectional study.Settings: Department of Physiotherapy, Manipal College of Allied Health Sciences, Manipal University, Bangalore. **Materials and Methodology:** Thirtyasymptomatic individuals with the age group of 20-30 years were included in the study, Unsupported Upper Limb Exercise test (UULEX) and Modified Upper Limb Exercise test (MUULEX) were performed by subjects seated erect in a straight-backed chair with both feet's on the floor facing the wall on which the UULEX chart was mounted. The weight of the bar was increased each minute from 500gm to 1kg to 1.5kg to 2kg. The MUULEX test was performed with the progression of 100gm.Each subject progressed through this test until he or she indicated an inability to continue. **Measurements:** Student paired 't' test for the pre and post changes in the variables (Heart Rate, Respiratory Rate, Weights) for each of the groups. Unpaired 't' test was used analysis between the two groups. **Conclusion:** MUULEX test is found to be better than UULEX test in eliciting symptom limited exercise performance much earlier with lesser weights

Keywords: Upper Limb Exercise Test, Heart rate,

INTRODUCTION

Homo sapiens is best described by three characteristics; brain size, upright biped position and highly developed use of the upper extremities and hands. The arms are used much differently than legs. Although the latter are used for posture and locomotion, the former require significant action against gravity which ranges from work (typing, painting) to sports (karate, baseball), but most importantly involves our daily care (eating, grooming, cleaning). Respiratory rate

Tangri and wolf et al studied the breathing pattern of seven patients while they tied their shoes or combing their hair. The patients developed an irregular, shallow, rapid pattern of breathing while performing the activity. Thus upper arm elevation results in dyssynchronous thoracoabdominal excursion and dyspnoea at an earlier time and at lower VO_2max than the more metabolically demanding leg exercise[1]. Takashi et al developed a new unsupported upper limb exercise test for patients with chronic obstructive pulmonary disease (COPD).The test was a reproducible and acceptable for patients with COPD to evaluate upper limb function in these patients[2].

Normative value for the unsupported upper limb exercise test is not available. So the current study would aim to provide a baseline data for comparison with disease subjects. Efficient assessment and treatment of upper limb endurance of the normals and the abnormals would not be possible since the calibration for the test involves progression using 500gm weights. Thus, there is a need to modify the test to increase the sensitivity for application in pulmonary rehabilitation programs. The purpose of the study is to establish normative value of weights for the upper limb endurance in normal subjects, to increase the sensitivity of the unsupported upper limb exercise test through modification of the test by using 100gm weights and to compare the findings of unsupported upper limb exercise test with the modified test for changes in heart rate, respiratory

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METHODOLOGY

The study is a cross sectional study design. The inclusion criteria was asymptomatic individuals with the age group of 20-30 years and exclusion criteria were subjects with the history of smoking, history of neck, shoulder and back pain and subject who is performing regular exercises.

Unsupported Upper Limb Exercise test (UULEX)

Subject was seated erect in a straight-backed chair with both feets on the floor facing the wall on which the UULEX chart was mounted. A pillow was provided for back support. The UULEX chart consisted of eight horizontal colour strips of paper pasted on the board of 0.84 wide and 1.20m high. Each strip was 0.84m wide and 0.08m high and the distance between the centers of the strips was 0.15m.Each strip had a clearly visible stage number. The color of the strips from stage1 (bottom) to stage 8 (top) were dark blue, red, yellow, light green, pink, orange and light blue, respectively. The first level was adjusted to be at the level of patient's by altering the position of UULEX chart on the wall. The highest level the patient could reach was recorded.

The resting heart rate and respiratory rate were recorded. The subject held a light plastic bar (0.2kg) and moved it during the exercise test. The gauge of the bar was 25mm, and length was 0.84m. The subjects were allowed 10mins rest period to acclimatize before the test. The highest stage the subject could reach without excess forward trunk movement was recorded. A 2 minute warm-up was performed using a 300gm bar, which was moved from the waist with both hands to stage number 1 and back to the waist at a constant rate of 30 times per minute, set by an metronome. After the warm-up, the subject lifted the bar to the next colored level (stage2) at the same rate for 1 minute.

This pattern of reaching to progressively higher colored stage for 1minute continued until maximum height was reached. the subject then continued to raise the bar to this maximum height, but the weight of the bar was increased each minute from 500gm to 1kg to 1.5kg to 2kg.Each subject progressed through this test until he or she indicated an inability to continue. If a subject completed all the work levels before indicating the need to stop, this test was not considered a measure of peak unsupported arm exercise capacity. The level of the maximum height reached and the particular weight bar used is recorded[3].

Modified Upper Limb Exercise test (MUULEX)

weights being increased from 500gm with the progression of 100gm till subject is unable to perform the test.

Data analysis

Data was analyzed through student paired t test for the pre and post changes in the variables (HR, RR, Weights) for each of the groups. Unpaired t test was used analysis between the two groups. The variables were taken as dependent measures and the groups were taken as independent measures and p value was set as <0.05 for level of significance. It was analyzed with SPSS version 14.0.

RESULTS

Of the 30 subjects included in the study, 15 males and 15 females participated in the study. Comparison between between Unsupported Upper Limb Exercise test (UULEX) and Modified Unsupported Upper Limb Exercise test is shown in Table 1. The comparison between weights of UULEX and MUULEX is shown in Table 2. Table 3 shows the comparison within subject in modified and normal groups.

DISCUSSION

The study was done with cross sectional study design, data shows baseline heart rate and respiratory rate were similar between normal UULEX and modified UULEX. This shows the homogeneity

Fig 1. UULEX chart and weighted plastic bars

Fig 2. Starting position of UULEX test

Fig 3. Maximum position reached during UULEX test

of the subjects in the study. Statistics indicate there was no influence of the order of intervention.Pre and post heart rates following the test were significantly increased in both the groups. Three reasons attributed to increase in heart rate are exercise with smaller muscle groups of the arm resulted in pronounced rise in sympathetic tone. When arm and leg exercise periods are compared on the basis of equal oxygen uptakes, the work per unit section area of muscle will be higher for arm exercise, which may be a contributing factor to the remarkably high sympathetic tone which may be elicited. Secondly during exercise with vertically elevated forearm blood flow and deep venous oxygen saturation were lower and lactate production larger than at exercise with the arm horizontal. It is probable that the increased lactate concentration is a result of both increased production and decreased dilution because of lowered blood flow due to increased peripheral resistance and finally the cardiovascular response is largely attributable to an increase in sympathetic tone which, in turn, is known to be associated with an increased contractility and rate of fiber shortening in the myocardium. Thus myocardial oxygen consumption is increased during arm exercise with elevated arms.

Pre and post respiratory rate also showed significant increase in both the groups. This might be due to two mechanisms such as at rest, the diaphragm is the dominant active inspiratory muscle, displacing the abdomen and increasing intra abdominal pressure while raising the lower rib cage and decreasing pleural pressure. During exercise, the inspiratory

Table 1

	Group	N	Mean	SD	t	P*
MpreHR	Modified	30	77.0000	3.59118	1.02700	0.309
	Normal	30	78.0667	4.40950		
MpostHR	Modified	30	90.4667	10.87463	1.14700	0.256
	Normal	30	93.6000	10.27082		
MpostHR3	Modified	30	84.6667	8.37621	0.88900	0.378
	Normal	30	86.5333	7.87722		
MpreRR	Modified	30	19.5333	2.86156	0.34200	0.734
	Normal	30	19.2667	3.17244		
MpostRR	Modified	30	24.2667	4.54049	0.28200	0.779
	Normal	30	24.6000	4.61332		
MpostRR3	Modified	30	21.6667	3.67971	0.10500	0.917
	Normal	30	21.7667	3.69233		

*__Statistically not significant__

Table 2

	Group	N	Mean (SD)	t	p
Mwt	Modified	30	653.33 (150.82)	5.58	0.001
	Normal	30	1266.67 (583.29)		

Mean data shows for modified exercise group achieved 700gms and normal exercise group achieved 1000gms at the end of the test.

accessories are progressively recruited to assist the diaphragm and elevate the ribcage. Unsupported arm exercise may be more limiting than leg exercise due to derecruitment of the shoulder girdle muscles from their ventilatory contribution, and shifting the ventilatory work to the diaphragm. And arm elevation results in changes in the impedance of the torso, ribcage or abdominal wall. Such changes would require diaphragmatic work to meet ventilatory demand.

The subjects in modified UULEX stopped the increased lactic acid accumulation impairing further progression of exercise test. The mean weight lifted during termination of exercise was 700gms. Comparison of post heart rate and respiratory rate between groups did not show significant difference. Normal exercise test was started with 500 Gms and gradually adding 500 gms weight. The increase in weights for the modified test was 100gms from 500gms.The mean weight achieved during end of normal endurance test was 1000gms.The subjects in the modified test reached the symptom limited maximum (fatigue) with the cardio respiratory

Table 3

Group		Paired difference Mean (SD)	t	p
Modified	MpreHR – MpostHR	-13.5 (10.15)	-7.26	0.001
	MpreHR - MpostHR3	-7.66 (8.31)	-5.06	0.001
	MpostHR - MpostHR3	5.8 (4.91)	6.47	0.001
	MpreRR - MpostRR	-4.73 (2.95)	-8.8	0.001
	MpreRR - MpostRR3	-2.13 (2.46)	-4.75	0.001
	MpostRR - MpostRR3	-2.6 (2.88)	4.94	0.001
Normal	MpreHR - MpostHR	-15.53 (8.39)	-10.13	0.001
	MpreHR - MpostHR3	-8.47 (5.96)	-7.78	0.001
	MpostHR - MpostHR3	7.07 (6.34)	6.10	0.001
	MpreRR - MpostRR	-5.33 (3.69)	-7.92	0.001
	MpreRR - MpostRR3	-2.5 (3.25)	-4.22	0.001
	MpostRR - MpostRR3	2.8 (2.83)	5.49	0.001

Analysis shows a significant increase in post exercise heart rate and respiratory rate when compared with base line, in both the groups.

subjects in the normal UULEX. Thus modified test with increments of weights with 100gms is efficient in eliciting symptom limited response than the normal UULEX with increments of 500gms.

CONCLUSION

MUULEX test is found to be better than UULEX test in eliciting symptom limited exercise performance much earlier with lesser weights. This improved sensitivity of the MUULEX test will have a important implication for assessment and treatment in pulmonary rehabilitation programme.

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