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Original article

THE INFLUENCE OF A RESISTANCE TRAINING PROGRAM ON THE PHYSICAL CONDITION OF PEOPLE WITH SPINAL CORD INJURY FROM MOTIVATION ROMANIA

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Abstract

Aim. The physical performance and quality of life of wheelchair users are limited due to overuse injuries in the upper limb, being carpal tunnel syndrome, tendonitis of the rotator cuff and elbow muscles the more common injuries that occur in these types of people.Poor propulsion technique aggravates muscle pain, which can be corrected by adequate strengthening of the agonist and antagonist muscles. Weight training has been observed to improve upper limb strength in people with SCI.The objective of this study was to evaluate the influence of resistance resistance training with weights on maximum strength, endurance strength, and displacement speed in spinal cord-injured wheelchair users.

Methods. Five wheelchair users participated voluntarily, the characteristics of which are illustrated in Table 1. The workouts were carried out three times a week for four weeks. The sessions lasted 50-60 min, during which time the strength exercises were performed. The testing session began with a standardized warm-up that consisted of 5 minutes of continuous propulsion displacement, shoulder elbow and wrist joint movements, pair resistance exercises, and progressions through the speed test space with accelerations. Subsequently, the following tests were performed in the order in which they are presented:displacement speed test, isometric maximal strength test, resistance force test.

Results. Training produced significant increases in movement speed (18.6%, $p < 0.05$). Strength improved 3.8%, but not significantly. Endurance strength, assessed by means of the fatigue index, improved 14.9% ($p = 0.08$). In data resulting from the mean values of the tests of all the subjects, before and after the four weeks of training, appear superimposed.

Conclusions. The results found in these studies make us think that the duration of a training program with this type of disabled population should be longer, around 8-12 weeks of work if we really want to find significant improvements in strength. According to the results of the present study, strength training with loads between 40-70% of 1RM produces improvements in endurance strength but is not suitable for increasing maximal isometric strength. To achieve significant improvements in the maximum force values we would have to work with maximum or submaximal loads with more than 70-80% intensity, but it is not advisable according to the bibliography consulted, since it produces a high risk of injury to the shoulder joints and elbow. The result obtained with our participants in this study has a fatigue index of 14.9%, much lower than the results with healthy people. This great difference between the two may be due to the fact that wheelchair users have to constantly propel themselves with their arms, with which they have much more work on resistance than healthy people, with which the variation in force is less than compare the beginning with the end of the test. Resistance training through traditional muscle-building exercises in spinal cord injuries is recommended, since it will improve performance in daily activities such as wheelchair propulsion. This type of work will have a favorable impact on the quality of life of these people.

Key Words: resistance training, spinal cord injury, program, wheelchair.

Introduction

The physical performance and quality of life of wheelchair users are limited due to overuse injuries in the upper limb, being carpal tunnel syndrome, tendonitis of the rotator cuff and elbow

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muscles the more common injuries that occur in these types of people (Gellman et al., 1998).

In addition, 72% of individuals with spinal cord injury (SCI) have degenerative evidence in the shoulder (Lal, 1998), most of them produced by the repeated loads to which said joint is subjected during propulsion in Wheelchair. Poor propulsion technique aggravates muscle pain, which can be corrected by adequate strengthening of the agonist and antagonist muscles (O'Connell et al., 1995, Rodgers et al., 2001 and Jacobs et al., 2002).

Weight training has been observed to improve upper limb strength in people with SCI (Rodgers et al., 2001; Jacobs et al., 2002), recommending resistance training with progressive loads to obtain this purpose. type of population (O'Connell et al., 1995 and Jacobs et al., 2002).

In these two studies the intensity of the training load is increased from 40% to 70% of 1RM. Improving muscle strength can lead to greater propulsion efficiency from a biomechanical point of view, as it reduces stress on the joints (Rodgers et al., 2001).

The studies analyzed in which the influence of different training programs on the muscular strength of subjects with SCI were combined with weight training with a wheelchair ergometer (Rodgers et al., 2001, Jacobs et al., 2001 and 2002). It has not been found to evaluate the influence of strength resistance training with weights as the sole method of work.

The measurement instruments used in subjects with SCI to analyze the adaptations produced by strength training have mainly consisted of isokinetic dynamometers (Davis and Shephard 1990; Maïsetti et al. 2002), arm ergometers (Jacobs et al., 2002) and ergometric wheelchair (Yim et al., 1993; Rodgers et al., 2001).

None of the studies consulted performed a resistance strength test in the wheelchair itself using a load cell. Similarly, only one study analyzed the influence of force work on displacement speed (O'Connell et al., 1995).

Therefore, the objective of this study was to evaluate the influence of resistance resistance training with weights on maximum strength, endurance strength, and displacement speed in spinal cord-injured wheelchair users.

Methods

Five wheelchair users participated voluntarily, the characteristics of which are illustrated in Table 1. A required inclusion criterion was the use of the wheelchair on a regular basis for at least one year.

Table 1. Characteristics of the subjects who participated in the study

Subject	Age (years)	Weight (kg)	Height (m)	Injury	Injury years	Spasticity level	Injury causes
1	31	100	1,75	D8	6	High	scaffold fall
2	29	75	1,76	D5-D6	2	Medium	Traffic accident
3	31	70	1,90	C6-C7	5	High	Traffic accident
4	31	70	1,76	D4	1	High	Traffic accident
5	36	72	1,66	C5	3	Medium	Traffic accident
Media ; SD	31,6 ;2,6	77,4;12,7	1,76;0,08		3,4 ;2,1		

Studies based on electromyographic recordings (EMG) have observed that the biceps and triceps brachii, deltoids, pectoralis major and the trapezius are preferentially activated during propulsion (Mulroy et al., 1996; Chow et al., 1999).

Therefore, strength work should focus on these muscle groups. Based on these results, many authors agree to use the following exercises with weights: military press, bench press, bicep curl, triceps curl, row and chest pulldown (Jacobs et al., 2002, Salinas Duran et al., 2001, O'Connell et al., 1995, Nash et al., 2002).

The workouts were carried out three times a week for four weeks. The sessions lasted 50-60 min,

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during which time the strength exercises were performed.

The structure of the session was as follows: warm-up: it consisted of elbow and wrist joint mobility exercises, biceps, triceps, pectoral and deltoid stretches with a total duration of 6 min.; training.

In the first session, a previous test was carried out on the participants in which they had to perform 1RM with the maximum possible weight with each exercise.

Based on this weight, the intensity percentages of the workouts were found. They started working with 40% reaching 70% in the last week of training. The number of series varied between 3-4 and the repetitions between 20-30. The breaks between series were 1 min. and between exercises of 5 min.

The exercises performed were given in the following order: bicep curl, tricep curl, dumbbell military press, chest pulldown, bench press and dumbbell deltoid; stretching: At the end of each session, group stretches were performed involved in each exercise.

Assessment sessions

An intra group experimental design was used with two tests performed before and after the training sessions. One week before the pretest, the subjects underwent a familiarization session with the assessment tests.

The testing session began with a standardized warm-up that consisted of 5 minutes of continuous propulsion displacement, shoulder elbow and wrist joint movements, pair resistance exercises, and progressions through the speed test space with accelerations. Subsequently, the following tests were performed in the order in which they are presented:

Displacement speed test.

It consisted of traveling 15 m in a wheelchair at the maximum possible speed (Kilkens et al., 2004). The time was recorded with infrared photoelectric cells (Globus Italia) with a recording frequency of 100 Hz. Half a meter before the first photocell barrier, a line was drawn on which the front wheels of the machine had to fall chair. The test was carried out three times taking the best attempt as the value to be analyzed.

Isometric maximal strength test.

Subjects had to exert maximum force as fast as possible for 6 s. The force was recorded by a load cell (Globus Italia) connected to a laptop, where the data was stored (sampling frequency = 100 Hz). The load cell was linked by chains at one end to the two rear wheels, blocking their rotation, and at the other end to the trellis.

Resistance force test.

It consisted of maintaining the maximum possible force for 60 s, developing the test in the same way as the previous one. This test was performed once and the fatigue index ((Fmax-Ffinal) * 100 / Fmax) was analyzed. In the two strength tests, the subjects could place their hands in the area of the hoop where they were most comfortable, but this position was noted and maintained in the successive tests.

Results

Table 2 shows the results of the comparison of the tests before and after training, corresponding to the displacement speed, the maximum force and the fatigue index.

Table 2. Results obtained in the tests before and after training.

	Pretest	Postest	*P*
Time for 15m (s)	6,27 ; 0,82	5,94; 0,80	0,043*
IMF(N)	395,8 ; 104,9	411,1 ; 96,7	0,225
IF (N)	215,9 ;107,4	183,6;26,2	0,080

*Values are expressed as mean ± standard deviation. IMF = maximum isometric force; IF = fatigue index; * = significant difference (p <0.05).*

Training produced significant increases in movement speed (18.6%, p <0.05). Strength improved 3.8%, but not significantly. Endurance strength, assessed by means of the fatigue index, improved 14.9% (p = 0.08).

Discussion

The results of the present study show that a four-week resistance training improves the speed of movement in wheelchair users and tends to decrease the fatigue index. The tests carried out in the present study were carried out in the person's own wheelchair, so transferring the benefits obtained to the real situation can be considered as high.

The improvement in speed produced in this type of exclusive weight training makes us think that, in previous studies such as those by O'Connell et al. (1995) and Nash et al. (2002) where they combined weight training with wheelchair ergometer training, the improvement in speed is largely due to the work with weights itself.

The percentages of speed increase are similar to the result obtained in this study, being 20.2% and 17.8% respectively, and 18.6% in the present study. It has not been observed in any of these studies if this improvement in speed can be attributed to a greater amplitude or stroke frequency, an aspect that may be the subject of future studies.

No research has been found that examines the effects of training based exclusively on strength resistance with weights, since most studies are based on general resistance training that complements cardiovascular work with strength, with equipment such as a wheelchair ergometer, arm ergometer (Davis and Shephard 1990; Yim et al., 1993; O'Connell et al., 1995; Rodgers et al., 2001; Jacobs et al., 2002; Bonaparte et al., 2004).

In some of these studies it was observed that after a training of 8 and 16 weeks there was a significant improvement in strength in the muscles that are most involved in the propulsion movement, which are the biceps and triceps (Davis and Shephard 1990). We can also find in other studies such as the one by Jacobs et al. (2001) that after a 12-week program of training with cardio-respiratory work complemented with weight work, there are significant improvements in strength in military press exercises (19.4%), horizontal row (20.8%), peck dec (21.1%), preacher curls (11.9%), latissimus pull down (23.2%) and dips (30.2%).

The results found in these studies make us think that the duration of a training program with this type of disabled population should be longer, around 8-12 weeks of work if we really want to find significant improvements in strength.

According to the results of the present study, strength training with loads between 40-70% of 1RM produces improvements in endurance strength (Jacobs et al. 2001), but is not suitable for increasing maximal isometric strength. To achieve significant improvements in the maximum force values we would have to work with maximum or sub maximal loads with more than 70-80% intensity, but it is not advisable according to the bibliography consulted, since it produces a high risk of injury to the shoulder joints and elbow (Salinas Duran et al., 2001; Jacobs et al. 2001).

Although the improvements observed in this study were not significant (14.9, p = 0.08), we can attribute this lack of statistical significance to the small number of subjects who participated in the study. Therefore, in order not to statistically commit a type II error, we believe that the training carried out does improve the fatigue index.

No studies have been found that evaluate the fatigue index in spinal cord injuries. In isometric strength endurance tests performed on healthy subjects, it was observed that arm strength decreased by 55% from the beginning to the end of the test (Yamaji et al., 2002 and 2006).

The result obtained with our participants in this study has a fatigue index of 14.9%, much lower than the results with healthy people. This great difference between the two may be due to the fact that wheelchair users have to constantly propel themselves with their arms, with which they have much more work on resistance than healthy people, with which the variation in force is less than compare the beginning with the end of the test.

One of the advantages of this work is that the improvements observed in spinal cord injuries were obtained when training with a material that can be found in any gym. On the contrary, in other studies in which improvements in muscle strength were observed in this type of population, more sophisticated means were used that are difficult to access (Davis and Shephard 1990; Yim et al., 1993; Maïsetti et al. 2000; Rodgers et al., 2001; Jacobs et al., 2002 and Maïsetti et al. 2002).

This circumstance is more important if it is intended to provide all people with training that prevents them from possible overuse injuries, as well as helping them to be more efficient in their daily lives (O'Connell et al., 1995; Rodgers et al. , 2001; Jacobs et al., 2002).

The results of this study may be limited by the use of a single study group, although most of the research reviewed does not use a control group. (Yim el al., 1993; O'Connell et al., 1995; Rodgers et al., 2001; Jacobs et al., 2002; Bonaparte et al., 2004). However, in this study there was a control period that served to familiarize the subjects with the assessment tests, reducing the influence of the learning effect and increasing the reliability of the tests. The small number of participants is a common aspect of studies evaluating this type of population (Davis and shephard 1990; Yim el al., 1993; O'Connell et al., 1995; Rodgers et al., 2001; Jacobs et al. ., 2002; Bonaparte et al., 2004), possibly due to the difficult accessibility to this type of population and the problem of joining subjects with similar injuries.

According to Hagberg et al. (2000) in a study about the improvements that people with shoulder injuries can suffer, isometric tests added to a strength training decrease the injuries of this joint.

Conclusions

The resistance strength training added to isometric strength tests and exercises performed with this training are beneficial both for the prevention and rehabilitation of overuse injuries in the shoulder.

Resistance training through traditional muscle-building exercises in spinal cord injuries is recommended, since it will improve performance in daily activities such as wheelchair propulsion. This type of work will have a favorable impact on the quality of life of these people.

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