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POSTURAL CONTROL ASSESSMENT IN PHYSICALLY ACTIVE AND SEDENTARY INDIVIDUALS WITH PARAPLEGIA

AVALIAÇÃO DO CONTROLE POSTURAL EM INDIVÍDUOS COM PARAPLEGIA FISICAMENTE ATIVOS E SEDENTÁRIOS

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ABSTRACT

Objective: The aim of this study was to evaluate functional independence and trunk control during maximum-range tasks in individuals with spinal cord injuries, who were divided into sedentary (SSI, n=10) and physically active (PASI, n=10) groups. Methods: Anamnesis was conducted and level and type of injury were identified (according to the American Spinal Injury Association protocol, ASIA) and the Functional Independence Measure (FIM) questionnaire was applied. For the forward and lateral reach task, the subjects were instructed to reach as far as possible. Mean data were compared using the unpaired t test and Mann-Whitney test and differences were considered significant when $p<0.05$. Results: The PASI group performed better in self-care activities (PASI: 40.8±0.42 points, SSI: 38.0±3.58 points, p=0.01), sphincter control (PASI: 10.5±1.84 points, SSI: 8.2±3.04 points, p=0.02), transfers (PASI: 20.7±0.48 points, SSI: 16.9±4.27 points, p=0.04), and total FIM score (PASI: 104.0±2.30 points, SSI 105.1±8.56 points, p=0.01). On the maximum reach task, the PASI group had a greater average range in all directions evaluated ($p<0.05$). Conclusion: The continuous practice of exercise increased motor function independence and trunk control in individuals with complete spinal cord injury. ***Level of Evidence II, Prospective Comparative Study.***

Keywords: Motor activity. Sedentary lifestyle. Recovery of function. Spinal cord injuries. Cross-sectional studies. Postural balance.

RESUMO

Objetivo: O objetivo deste estudo foi avaliar a independência funcional e o controle de tronco durante tarefas de alcance máximo em indivíduos com lesão medular, que foram divididos em grupo sedentário (SSI, n = 10) e grupo fisicamente ativo (PASI, n=10). Métodos: Foi realizada anamnese, identificação do nível e tipo de lesão (de acordo com o protocolo da ASIA - American Spinal Injury Association), e aplicou-se o questionário de Medida de Independência Funcional (MIF). Para a tarefa de alcance anterior e lateral os indivíduos foram instruídos a fazer o alcance máximo. Para comparação das médias dos dados foram aplicados o teste t não pareado e teste de Mann-Whitney, e as diferenças foram consideradas significativas quando $p < 0,05$. Resultados: O grupo PASI teve melhor desempenho na realização de atividades de autocuidado (PASI: 40,8 ± 0,42 pontos, SSI 38,0 ± 3,58 pontos, p = 0,01), controle de esfíncter (PASI: 10,5 ± 1,84 pontos, SSI 8,2 ± 3,04 pontos, p = 0,02), transferências (PASI: 20,7 ± 0,48 pontos, SSI 16,9 ± 4,27 pontos, p = 0,04) e MIF total (PASI: 104,0 ± 2,30 pontos, SSI 105,1 ± 8,56 pontos, p = 0,01). No alcance máximo, o grupo PASI teve maior alcance médio em todas as direções avaliadas ($p < 0,05$). Conclusão: A prática de exercício físico contínuo aumentou a independência funcional motora e o controle de tronco em indivíduos com lesão medular completa. ***Nível de Evidência II, Estudo Prospectivo Comparativo.***

Descritores: Atividade física. Estilo de vida sedentário. Recuperação de função fisiológica. Traumatismos da medula espinal. Estudos transversais. Equilíbrio postural.

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INTRODUCTION

Spinal injury is due to trauma or to a disease that, depending on the spinal level affected, can generate a disabling condition that alters motor, sensory and autonomic function in affected individuals, leading to adaptations and changes of habits in order to adapt to the new reality.[1] These changes may severely affect the functional independence of persons with spinal injury.

The stability of the pelvic girdle and of the lumbar spine is very important for body balance and trunk control in persons with spinal injuries. In order to perform routine activities such as driving a wheelchair,[2,3] getting dressed, bathing, and transferring positions, these individuals need lumbar-pelvic stability, which is mainly provided by the action of spinal and abdominal erector muscles[4] This stability permits the subject to keep his balance and to be

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able to perform movements of the trunk and upper limbs during the tasks proposed.

There is evidence that regular physical activity is associated with increased functional activity, independence, reduction of events with adverse effects on health[5] and improved quality of life of persons with traumatic spinal injury. The cited authors emphasize that the regular practice of physical activity promotes control of joint mobility and increased aerobic resistance, muscle strength and bone mineral density. In addition to promoting physical benefits, physical activity promotes psychosocial benefits such as increased self-esteem, stress relief and wellbeing, as well as maintenance of autonomy and reduction of depression.[6]

However, the practice of sports adapted for persons with paraplegia does not seem to change the pattern of activation of trunk muscles during the task of forward and lateral reach, although the pattern of muscle activation of persons with spinal injury differs from that of persons with no such injury.[7]

In view of the physiological benefits that adapted sports can have for persons with spinal cord injury, there is a need to compare trunk control and performance during the execution of daily activities between individuals with paraplegia who practice or not adapted exercise.

A more in-depth understanding of the benefits of adapted sports for balance and functionality is important in order to provide a scientific basis for the encouragement of the participation in sports of persons with paraplegia and to elaborate a complementary strategy in order to help improve the independence and quality of life of these individuals.

Our hypothesis is that individuals who practice adapted sports may have better control of the trunk and consequently a better performance in the execution of functional activities.

Thus, the objective of the present study was to assess and compare postural control and functionality between paraplegic subjects who regularly practice physical exercise and those who do not.

METHODS

This was a cross-sectional study. For sample calculation we considered the total value of the Functional Independence Measure (FIM), considered to be one of the major outcomes. Mean values and standard deviations were obtained in a pilot study of 5 volunteers per group. This resulted in a total sample size of 20 individuals who were divided into two groups. The GPower 3.1 software was used for this calculation, considering a sample power = 0.92, α=0.05 and effect size = 0.43.

We selected 20 subjects with complete traumatic spinal injury at a neurological level between T1 and T12 according to the classification of the American Spinal Injury Association (ASIA).[8] The participants were divided into two groups: sedentary subjects with spinal injury (SSI, n=10) and physically active subjects with spinal injury (PASI, n=10).

Subjects who engaged in some sport or physical activity of one hour duration at least 3 times a week and for at least 6 consecutive months were considered to be physically active. The sports activities included in the study were basketball, handball and badminton. The physically active participants were recruited at the Laboratory of Biomechanics and Rehabilitation of the Locomotor Apparatus of the University Hospital, UNICAMP, and at the Faculty of Physical Education, UNICAMP.

The sedentary group consisted of subjects who had not practiced any physical activity or adapted sport during the last year.

Exclusion criteria were: presence of neurological diseases associated with spinal injury or involvement of inferior motor neuron, or any other clinical entity causing comorbidities such as cardiac or orthopedic dysfunction, uncontrolled diabetes, distal degenerative disease, cognitive deficits, or psychiatric problems.

The study was approved by the local Ethics Committee (Protocol no. 12515/2013) and all subjects gave written informed consent to participate.

Application of clinical questionnaires

Subjects were first submitted to anthropometric measurements (height and body mass) and provided personal information such as age and duration of the injury for both groups and information about the pracice of physical activity for the physically active group.

Functionality was assessed using the Functional Independence Measure (FIM), which assesses the ability of patients with functional limitations of varied origin.[6,7] The FIM measures task execution performance regarding 18 items divided into the 6 following domains: personal care, sphincter control, mobility and transfers, locomotion, communication, and social cognition. The score for each question may range from 1 to 7.

The total score for the FMI questionnaire ranges from 18 to 126 points, with 18 points meaning full subject dependency (need for total assistance), 19-60 points meaning modified dependency (need for assistance in up to 50% of a task), 61-103 points meaning modified dependency (need for assistance in up to 25% of a task), and 104-126 points meaning modified full independence.[9]

Assessment of Balance

Postural balance was assessed using the anterior and lateral functional reach test.

Functional forward reach test

The participant was instructed to adopt the following position: sitting in his wheelchair, without support for the upper limbs, positioned lateral to the wall without touching it and keeping his shoulder flexed 90° at a distance of 10 cm from the wall. A measuring tape positioned at the height of the acromion was fixed parallel to the floor. The subject was then instructed to bend forward as much as possible without losing balance or shift the position of the wheelchair. (Figure 1)

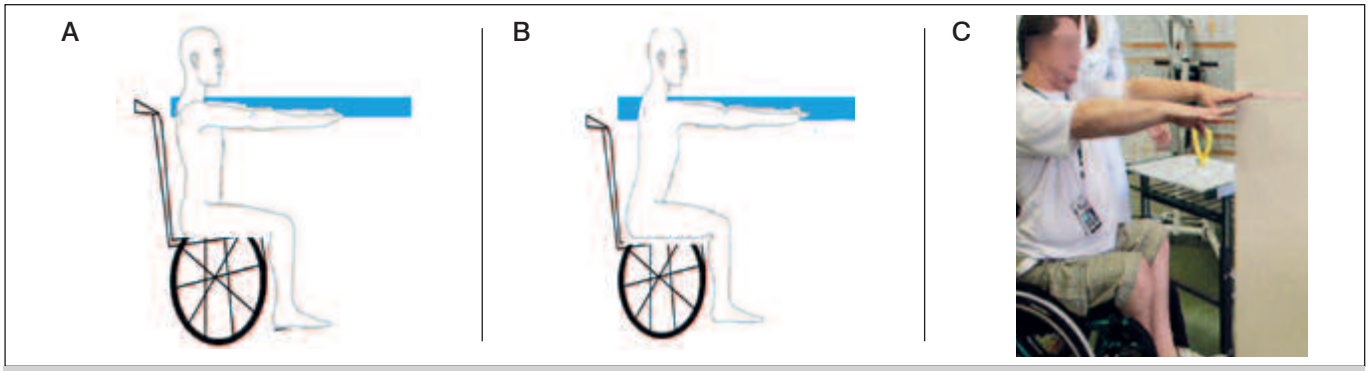

Figure 1. Figure illustrating the maximum forward reach test. A) Initial test position, with the blue band corresponding to the measuring tape; B) final test position; C) Volunteer performing the test.

Lateral reach test

The participant keeps his arms extended by the side of the chair as close as possible to his body so that the distance between his hand and the floor can be measured at rest (measure 1). Next, he is asked to perform lateral bending of the trunk as much as possible and the maximum distance of his hand from the floor is measured (measure 2). Lateral reach was defined as the difference between these two measures (Lateral reach = measure 1- measure 2). (Figure 2)

The types of reach were measured in three attempts and the mean of the three attempts was calculated. The subject was allowed to familiarize himself with the movement before the beginning of the tests.

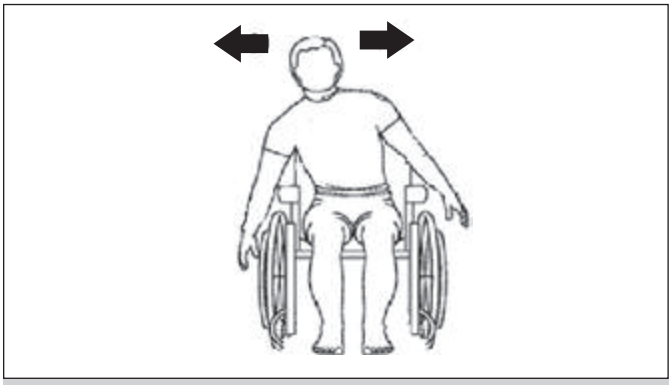

Figure 2. Illustration of the lateral reach test.

Statistical analysis

Descriptive statistics (mean ± SD) were calculated for the anthropometric measurements [height and body mass index (BMI)] and for age and duration of the injury. The Shapiro-Wilk test was used to determine data normality. For data with normal distribution, the Student t-test was used to determine differences between groups regarding anamnesis data, functional reach tests and FIM domains (sphincter control, locomotion, communication, social cognition, and total score). Data with non-normal distribution were analyzed by the Kruskal-Wallis test followed by the Mann-Whitney post-hoc test in order to determine differences between active and sedentary subjects. Data are reported as mean ± SD, with the level of significance set at $p < 0.05$.

RESULTS

Table 1 presents the characterization of the study sample. All participants had complete spinal cord injury (ASIA A).

There was no significant difference between groups regarding the anthropometric measurements performed ($p > 0.05$).

The physical activities practiced by the PASI group were: basketball (30%), handball (60%) and badminton (10%). Mean time of physical activity was 7.5±3.24 hours per week, practiced on average for 4.5 ±4.67 consecutive years.

The results obtained for the self-care, sphincter control, transfer, locomotion, communication and social cognition subscales of the FIM questionnaires are presented in Figure 3.

The score varies for each domain due to the number of questions present. The score ranges from 6 to 42 points for Self-care, from 2 to 14 points for Sphincter control, from 3 to 21 points for Transfer, from 2 to 14 points for Locomotion and for Communication, and from 3 to 21 points for Social cognition.

Figure 4 illustrates the total mean FIM values for the two groups studied.

The mean ± SD values obtained for the functional forward reach test and for the lateral right and left reach tests are illustrated in Figure 5.

Table 1. Sample characterization including anthropometric data and information about the duration and level of injury for the physically active and sedentary groups. Data are reported as mean and standard deviation.

	Age (years)	Weight (kg)	Height (meters)	BMI (kg/m²)	Duration of injury (years)	Level of injury
Physically Active Group	35.2± 6.28	75.37± 14.14	1.76± 0.08	25.14± 4.39	13.2± 6.89	T3A – T9A
Sedentary Group	37.3± 11.09	78.76± 16.82	1.73± 0.09	26.08± 3.62	8.9± 5.46	T3A – T8A

BMI = body mass index.

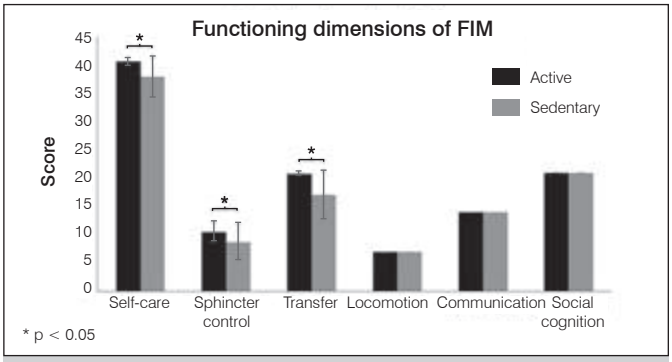

Figure 3. Values reported as mean + SD regarding the subscale of the FIM questionnaire.

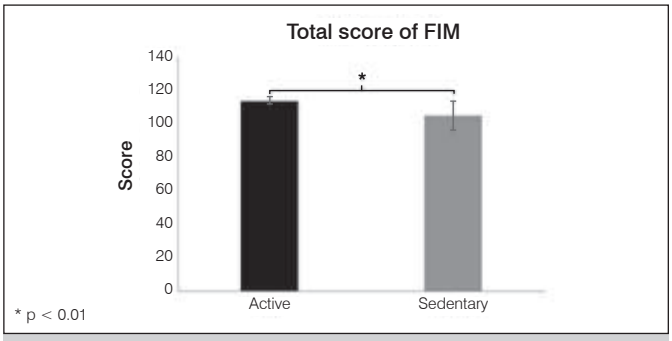

Figure 4. Mean + SD values of the total score for the FIM questionnaire.

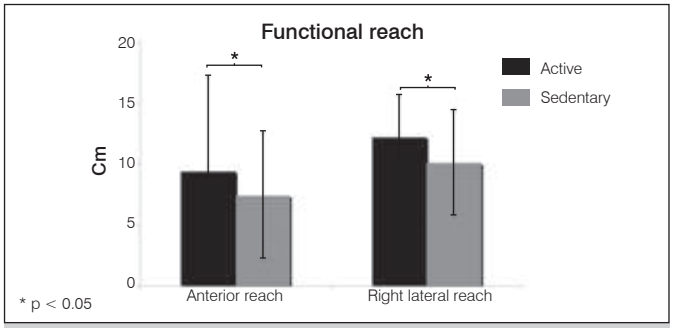

Figure 5. Mean + SD values of forward, right and left lateral reach for the groups of physically active and sedentary groups with spinal injury.

DISCUSSION

The present anamnesis data agree with those reported in several other studies of individuals with spinal cord injury. The age range of the participants at the time of spinal injury was 20-60 years and the mean age was 30-40 years, in agreement with the literature, which points out that the occurrence of spinal cord trauma is highest between 15 and 40 years of age and among men.[10-12] In the present

study we only included males since they corresponded to more than 80% of the volunteers recruited.

The best score for the active group was obtained for the subitems related to self-care, sphincter control and transfer, as well as for the final FIM score. These results suggest that individuals who regularly practice adapted physical exercise such as basketball, handball and badminton are more independent, mainly regarding motor aspects. Our results support those reported by Silva et al.,[6] who observed that physical exercise, swimming in their case, improved patient performance regarding transfers, motor aspects in general and the total score obtained with the FIM questionnaire.[6]

Since all subjects studied here have complete spinal cord injury, they have no motor or sensory control of the perineal region. However, the question of the FIM regarding sphincter control also assesses the number of urinary and fecal losses (daily, monthly or weekly), the use of some instrument for aid, or dependency on a person during bladder or intestinal emptying, among other things.. On this basis, the best result observed for the PASI group was a lower frequency of urinary or fecal losses, with no subject depending on another person's help for these activities. Thus, physically active subjects with spinal injury were found to be more cautious and disciplined at the times scheduled for bladder emptying and all reported a lower loss, a fact that resulted in a better FIM score.

In the present study we did not detect any cognitive change among the subjects with spinal injury evaluated. All showed the same score (7 points) for the locomotion domain (2-24 points) which assesses locomotion on flat or slightly inclined surfaces and stair climbing, since they all reported the same difficulties.

According to Vall et al.,[13] persons with spinal cord injury suffer an important reduction of quality of life mainly regarding social aspects. For this reason, in the present study we applied the complete FIM questionnaire since the impact of physical exercise also on social aspects represents relevant information for this population. However, we did not observe an impact of physical activity on the social life of the subjects.

The sitting functional reach test[14] represents a clinical assessment of postural control that measures the maximum reach distance. It is a reliable test that can be used also for subjects with spinal cord injury.[15,16]

According to a battery of tests applied to persons with spinal cord injury in 2014, forward and lateral reach is part of the daily activities for which these individuals have greatest difficulty, a fact showing the importance of the assessment of these movements.[17]

In the present study the active group showed greater forward and bilateral functional reach than the sedentary group, suggesting that continuous physical exercise promotes better trunk control. According to Santos et al., victims of spinal cord trauma who practice basketball in a wheelchair are able to move their trunk anteroposteriorly and laterolaterally more rapidly than sedentary persons with the same injury.[18]

Patients with spinal cord injury, because of the loss of muscle activation below the level of the injury, use new patterns of muscle activation employing intact muscles in order to adapt and to maintain postural control and stability during routine activities.[19] In a recent study (2016) conducted on paraplegic subjects, trunk electromyography results indicated that sports practice did not affect the bilateral activation of the longissimus, iliocostalis and multifidus muscles compared to sedentary individuals. However, a different pattern of muscle activation was observed iin forward reach tasks in the subjects with spinal injury compared to uninjured persons.[7] In the present study we suggest that physical activity can be of help for the improvement of these new motor patterns among subjects with spinal cord injury, thus contributing to a better postural control and to greater functional independence.

The present study had limitations regarding the use of the FIM questionnaire, since the subjects are assessed by means of self-reports and not by examiner's observation of the type of execution and quality of movement of the task in question. In addition, only some sport modalities (basketball, handball and badminton) were included, while it would be interesting to compare trunk control between various modalities.

CONCLUSION

We conclude that subjects with spinal cord injury who perform physical exercise have greater functional independence regarding motor, self-care and transfer functions, as well as better trunk control as determined by the forward and lateral functional reach tests.

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