Effects of swimming on the functional independence of patients with spinal cord injury

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ABSTRACT

Fundaments and objective: Sports play an important role in the physical rehabilitation of patients with spinal cord injury by broadening the therapeutic alternatives in addition to providing functional independence. The objective of this study is to determining the effects of swimming on the functional capacity of patients with spinal cord injury. **Methods:** 16 patients with spinal cord injury were divided into two groups: experimental and control. The assessment of both groups was performed using the Functional Independence Measure (FIM scale) before and after the trial, which consisted of swimming sessions performed twice a week during a period of four months. **Results:** Both groups demonstrated noticeable gains related to body care, transference, overall and motor scores, even though the experimental group presented greater gains in transference, overall motor score and overall score. **Conclusion:** The swimming activity was effective in improving their physical condition, bringing motor benefits on the functional capacity of participants from the experimental group.

Key words: Spinal cord injuries. Swimming. Functional independence. Rehabilitation.

INTRODUCTION

The medicine advancements occurred in the last decades and the consequent increase on the survival rate of patients with spinal cord injury[1] (SCI) were followed by and evolution on the respective treatment that today is part of the medical care for being vital in the facing of "disadvantages" by handicaps. Sports play an important role in the rehabilitation process: it complements and enlarges alternatives; stimulates and develops physical, psychological and social aspects and furthers independence[2-6].

Therapeutic effects of the sportive activity

The benefits of the physical training on athletes with SCI reported in literature are: enhanced oxygen uptake ($\dot{V}O_2$max.)[7-10], aerobic capacity gain[10], reduction on the risk of cardiovascular diseases[8,9] and respiratory infections[10], decrease on the incidence of medical complications[8,11] (urinary infections, scabs and renal infections), reduction on hospitalizations[8,10,11], increase on the life expectancy[12], increase on the social integration levels[5], support on the facing of the disability[13], improvement on the self-image, self-esteem and life satisfaction[14,15] and decrease on the probability of psychological disturbances[9].

Heath and Fentem[16] emphasize evidences pointed by several studies in which the regular practice of physical activities is associated to the increase on the functional status and quality of life of individuals with disabilities. The authors also emphasize that the regular practice of physical activities avoids diseases, promotes health and preserves the functional independence.

The sportive practice in the hospitalization condition, in turn, complements the medical and physiotherapeutic care, reduces the hospitalization time, increases the independence degree and the initiative capacity, contributes for the education and the adoption of behavioral procedures in order to assure the continuity of the process aimed at the physical and mental health and social welfare[17].

The objectives of the sports for paraplegics and tetraplegics are: to promote education for health, to educate the individual for life in society and leisure, to provide successful experiences, to increase the tolerance to frustration, to promote social contact, to make individuals more independent[15-18], to improve self-image and self-esteem, to develop the residual potential, to improve the organo-functional condition and to improve the physical qualities (resistance, strength and velocity)[18].

Studies conducted by Bauman and Spungen[19] revealed that the lack of movement and a prolonged inactivity in individuals with SCI promote the reduction on the glucose intolerance level with association with hyperinsulinemia, being minimized with short periods of physical activity. The moderate intensity physical activity reduces the basal insulin secretion in response to a carbohydrate load. The study revealed that the inactiveness increases the risk of developing diabetes mellitus and early aging in this population.

Individuals with SCI, who practice regular physical activities, perceive benefits not only in their physical and emotional health, but also gains in their general functionality[8].

Swimming for individuals with spinal cord injury

Souza[17] emphasizes, among the swimming therapeutic resources, the prevention of secondary disturbances and inactiveness, the partial improvement on the affected or non-affected functions and the functional improvement of the trunk, arms and scapular waist musculature. Swimming, besides the water adaptation and the possibility of performing muscular work with no gravity action, provides the possibility of a continuous exercise of the respiratory, circulatory and muscular functions and decreases the spasticity[20]. Bates and Hanson[21] attribute such property to the fact that one reaches relaxation more easily in the water environment, besides producing a sensitive stimulation of temperature, touch and pressure. Moreover, swimming has shown benefits in the development of movements that promote a new postural control[22-24].

The swimming activity for individuals with disabilities has been defined as the capacity of dominating the water element, dislocating in a safe and independent way under and on the water by using their functional capacity and respecting their limitations[25,26]. Skinner and Thomson[27] suggest the following advantages of the water activity: the body weight relief, promoting gait training in individuals with locomotion difficulties; the muscular strengthening in function of the higher density of the environment, the muscular

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relaxation and the activation of the blood circulation as result of the turbulence effect.

Swimming provides the following advantages for paraplegics and tetraplegics: to experience new playful-motor options in water with no auxiliary means; to achieve the necessity of moving; relaxation; the reduction on the physical and psychic dependence; the social reinsertion; the transition between being "diseased" and "healthy", "able" and "unable" and "patient" and "pupil"; the temporary permanence out of the wheelchair and the prevention of scabs; the incentive to the will power, self-image, self-confidence and self-esteem[17].

Although there are so many studies on the benefits of the sports practice in literature, not much is known about the impact of such practice, particularly swimming, on the functional independence of patients with SCI. The functional independence measured through the FIM scale[28] evaluates the impact of the SCI on the daily activities and has called the attention of rehabilitation staffs[29-35]. Studies suggest that this scale provides subsides for a good correlation between the amount of data obtained and the diversity of professionals involved in the measurement of these data[13]; that the scale is reliable and sensible to changes related to the self-care and locomotion abilities and provides subsides for medical-therapeutic and research procedures[34,35].

The objective of this study was to verify the effects of a swimming program on the functional abilities of patients with SCI. The relevance of this study lies in the necessity of better understanding the role and contribution of the physical education for the rehabilitation staff to indicate this sportive modality to patients with SCI.

METHODOLOGY

Participants

Sixteen individuals with spinal cord lesion attended in the Sarah-Brasilia Hospital rehabilitation program, who live in the city of Brasilia were selected and divided into two groups. The participants were recruited according to the following inclusion criteria: 1) to be carrier of traumatic spinal cord lesion classified as ASIA "A"*, 2) to have participated in the rehabilitation program for a period equal to or greater than four weeks; 3) the time of injury must be shorter than four years and 4) to be clinically stable and to present no contra-indication to swimming.

The distribution of patients into experimental (EG) and control (CG) groups was performed in function of the condition to dislocate to the experiment site and the liability in participating constantly in the activities proposed. The EG was composed of eight participants (seven men and one woman) with ages ranging from 21 to 34 years, with time of injury ranging from one year and three months to three years and four months. The CG was composed of eight participants (seven men and one woman) with ages ranging from 21 to 41 years, with time of injury ranging from one year and two months to two years and two months (table 1).

TABLE 1
Distribution of participants of the experimental and control groups

Participant	Group	Gender	Age	Lesion level	Time of lesion (months)	Etiology
1	Experimental	M	21	C5	25	Dive in shallow waters
2	Experimental	M	25	T10-T11	16	Fall
3	Experimental	F	23	T8	22	Car accident
4	Experimental	M	34	T3	40	Motorcycle accident
5	Experimental	M	24	T9	22	Bullet of firearm
6	Experimental	M	25	T11	40	Car accident
7	Experimental	M	23	T10	15	Bullet of firearm
8	Experimental	M	22	L2-L3	24	Bullet of firearm
9	Control	M	24	C5-C6	14	Dive in shallow waters
10	Control	M	27	T8-T9	30	Car accident
11	Control	M	26	T12-L3	24	Fall
12	Control	M	22	T10	25	Bullet of firearm
13	Control	M	21	T12	26	Running over
14	Control	M	31	T11	22	Bullet of firearm
15	Control	F	23	T12	17	Car accident
16	Control	M	41	T4	19	Bullet of firearm

The participants signed a free and cleared consent term, according to resolution of the Brasilia Catholic University Ethics Committee, according to Norms of Researches Involving Human Beings[37]. The research was previously approved by the SARAH Net Ethics Committee.

Instrument

The FIM scale[28] (Functional Independence Measure) was used in order to evaluate the capacity of patients in relation to self-care, control of sphincters, mobility, communication and social integration in a 1-7 scale. This scale evaluates 18 items and the patient's score ranges from 18 to 126 points.

The scores are: 1 – total assistance; 2 – maximum assistance; 3 – moderate assistance; 4 – assistance with minimum contact; 5 – supervision or preparation; 6 – modified independence and 7 – full independence.

Full Dependence is considered when the patient performs less than 50% of the work and requires maximum assistance in order to perform activities and scores one and two. Modified Dependence is considered when the patient performs 50% or more of the work and in this case the score is three, four and five, depending on the assistance level. The patient who needs the help of an assistant in the supervision or in the physical assistance is considered as Dependent. The patient is considered as Independent when he does not need the help of anybody to develop a given activity. In this case, the score may be six or seven (depending on the use or not of some device or on the performance within reasonable time interval).

* The injury classification is measured through the ASIA scale (American Spinal Injury Association[36]) that classifies the lesion involvement as follows: ASIA "A" = complete; ASIA "B" = incomplete: preserved sensibility but there is no motor function below injury level. ASIA "C" = incomplete: motor function preserved below injury level and most key-muscles below neurological level present voluntary movement in the absence of the gravity force in the entire movement range. ASIA "D" = incomplete: motor function preserved below injury level and most key-muscles below neurological level present voluntary movement in the absence of the gravity force in the entire movement range.

The FIM scale is divided into two scores, which are subdivided into the following items: 1) Motor score: to eat, to get ready, to take shower, to dress the upper body, to dress the lower body, to use the bathroom, to control the bladder, to control intestines, to transfer from bed to the wheelchair, to transfer from wheelchair to the bathroom, transferences in bathroom and shower, wheelchair/stairs. 2) Cognitive score: comprehension, expression, social integration, resolution of problems, memory.

Data are collected at the first 72 hours after admission and discharge from hospital. The follow-up data should be collected between 80 and 180 days after discharge from hospital.

Procedures

All participants were submitted to FIM scale measurement in two occasions: at the discharge from hospital (pretest) and four months after the intervention period (posttest).

Among the activities performed in the rehabilitation program, the patients participated in orientation classes on several topics related to the spinal cord injury: explanations on spinal cord injury, vesicular-intestinal reeducation, sexual orientation and cares with skin. Besides classes and psycho-pedagogical follow-up, the patients performed physiotherapeutic activities such as locomotion training in wheelchair or gait training among others and sportive physical activities.

In relation to the CG, the only recommendation was in case patients engaged in any oriented physical activity, they should communicate to the study's organizers. At the moment of discharge from hospital, a return in four months for the performance of the posttest measurement was fixed to participants from both groups.

The EG started the swimming activity in the hydrotherapy sector of the hospital with the supervision of a Physical Education professor oriented to conduct the swimming class in its widest meaning: from adaptation to the water environment to the improvement of the swimming strokes.

The swimming concept is wide and allows different interpretations if aspects relative to the swimming strokes techniques and the way human beings move in the water environment are considered. In the perspective of the present research, we have adopted the concept of Burkhardt and Escobar[25], who consider swimming as the ability one presents of maintaining and moving himself on the water without touching the bottom, in other words, in an independent way. Thus, the fulfilling of the technical aspects of the four types of swimming strokes is not expected, but rather the evidence of his complete adaptation to the water environment.

The EG participated in swimming classes during this time interval (average of 30 sessions). The swimming classes took place twice a week with duration of 45 minutes each. The class time was distributed into: warm-up exercises, main part and back to calm situation. In the warm-up phase, the following exercises were performed out of the water: muscular stretching, training of transference from wheelchair to the ground and from the ground to the swimming pool, where different techniques to enter the swimming pool were tested. In the swimming pool, the exercises were aimed at the organic adaptation to the water. In the main part, exercises aimed at the independence in the water environment were developed, considering the change on the balance point and the movement referential. Crawl, backstroke and breaststroke educative exercises were performed. In the last part, the objective was the return to calm situation emphasizing relaxation, fluctuation and respiration. In this moment, techniques to get out of the swimming pool and the transference from the ground to the wheelchair were trained.

In order to minimize gauging errors, the posttest (120 days from pretest) measurements were performed by a single appraiser – a Nurse – who did not know which group the participant belonged to.

Data treatment and analysis

The paired "t" Test was used for the analysis of scores obtained in the application of the FIM scale at the admission and discharge from hospital and in the pre and posttest of experimental and control groups. For the comparison of averages of the FIM scale scores before and after the experiment between EG and CG, the "t" Test for independent samples was used.

The paired "t" test was selected for treating repeated measures and for being a small-size sample evaluation. Thence, the "t" test was also confirmed through the Wilcoxon test.

RESULTS

The characteristics of participants from both groups revealed no significant differences in relation to age (p = 0.26), gender (Fisher exact test, p = 0.76) and etiology. The averages of the FIM scale scores of the EG and CG measured in the pretest and posttest showed that, in general, the scores of the EG in the admission were better than scores of the CG, but tests presented no differences. In the discharge from hospital, the scores were comparable with no significant differences.

Table 2 presents the scores of the groups, showing the anterior and posterior situations of both groups in the experiment. The tests showed that both the EG and the CG presented changes after the experiment. The EG presented gains on seven distinct abilities and the CG on three. The EG presented significant changes in relation to abilities of body care (including bath and to dress the lower body); transferences (including bed-chair-wheelchair, bathroom, bathtub-shower); overall motor score and overall score. The CG presented significant changes in general scores related to the following abilities: body care (including bathroom); transferences; overall motor score and overall score.

TABLE 2
Distribution of cases according to the FIM scale scores before and after the experimental period

	Experimental group			Control group		
FIM Scale Scores	**Before**	**After**	**p***	**Before**	**After**	**p***
Body care	34.7	38.0	***0.01****	34.6	36.1	***0.02****
A – To eat	6.7	6.7	1.00	6.6	6.4	
B – To get ready	6.2	6.6	0.35	6.4	6.4	1.00
C – To take shower	5.7	6.5	***0.02****	5.1	5.7	0.14
D – To dress upper body	6.2	6.4	0.35	6.4	6.4	1.00
E – To dress lower body	5.0	6.2	***0.03****	5.1	5.5	0.20
F – To use the bathroom	4.7	5.5	0.26	5.0	5.5	***0.03****
Sphincter control	10.9	11.0	0.35	10.2	10.2	1.00
G – Bladder control	5.5	5.6	0.35	5.1	5.1	1.00
H – Intestine control	5.4	5.4	1.00	5.1	5.1	1.00
Transference	14.9	19.2	***0.00****	14.0	15.6	***0.04****
I – Bed, chair, wheelchair	5.1	6.4	***0.01****	4.7	5.4	0.05
J – Bathroom	4.9	6.5	***0.00****	4.7	5.4	0.05
K – Bathtub, shower	4.9	6.4	***0.01****	4.5	4.9	0.08
Locomotion	6.5	6.5	1.00	6.4	6.4	1.00
L – Gait/wheelchair	5.5	5.5	1.00	5.4	5.4	1.00
M – Stairs	1.0	1.0	1.00	1.0	1.0	1.00
Motor score – Subtotal	67.0	74.7	***0.00****	65.2	68.4	***0.01****
Communication	14.0	14.0	1.00	14.0	14.0	1.00
N – Comprehension	7.0	7.0	1.00	7.0	7.0	1.00
O – Expression	7.0	7.0	1.00	7.0	7.0	1.00
Social integration	21.0	21.0	1.00	20.9	21.0	0.35
P – Social interaction	7.0	7.0	1.00	6.9	7.0	0.35
Q – Resolution of problems	7.0	7.0	1.00	7.0	7.0	1.00
R – Memory	7.0	7.0	1.00	7.0	7.0	1.00
Cognitive score – Subtotal	35.0	35.0	1.00	34.9	35.0	0.35
Total score	102.0	109.7	***0.00****	100.4	103.1	***0.02****

* $p < 0.05$, with p associated to the "t" test for related samples.

Table 3 presents the average of gains reached between the beginning and end of the experiment between groups and one observes that the EG presented more significant gains in relation to the CG in the following abilities: transference (bathroom, bathtub and shower); overall motor score and overall score. Differences between groups were verified in two specific transference abilities (bathroom and bathtub-shower) and in the total motor result. Such observation revealed that the groups presented heterogeneous results and that, although both have presented significant gains, the experimental group presented higher gains (p = 0.01).

TABLE 3
Comparison of averages of gains between beginning and end of the experiment in both groups

	Experimental group		Control group			
FIM Scale Scores	**Average**	**SD**	**Average**	**SD**	**T**	**P**
Body care	3.25	2.55	1.50	1.41	1.70	0.11
A – To eat	0.0	0.0	0.0	0.0	–	–
B – To get ready	0.37	1.06	0.0	0.0	–	–
C – To take shower	0.75	0.71	0.62	1.06	0.28	0.79
D – To dress upper body	0.12	0.35	0.0	0.0	1.00	0.33
E – To dress lower body	1.25	0.35	0.0	0.0	1.67	0.12
F – To use the bathroom	0.75	1.75	0.50	0.53	0.38	0.70
Sphincter control	0.12	0.35	0.00	0.00	1.00	0.33
G – Bladder control	0.12	0.35	0.00	0.00	1.00	0.33
H – Intestine control	0.00	0.00	0.00	0.00	–	–
Transference	4.37	2.61	1.62	1.77	2.46	***0.02****
I – Bed, chair, wheelchair	1.25	0.89	0.62	0.74	1.53	0.15
J – Bathroom	1.62	0.92	0.62	0.74	2.40	***0.03****
K – Bathtub, shower	1.50	1.07	0.37	0.52	2.68	***0.01****
Locomotion	6.5	1.41	6.4	1.77	0.33	0.74
L – Gait/wheelchair	0.00	0.00	0.00	0.00	–	–
M – Stairs	0.00	0.00	0.00	0.00	–	–
Motor score – Subtotal	7.75	4.03	3.12	1.17	2.86	***0.01****
Communication	0.00	0.00	0.00	0.00	–	–
N – Comprehension	0.00	0.00	0.00	0.00	–	–
O – Expression	0.00	0.00	0.00	0.00	–	–
Social integration	0.00	0.00	0.12	0.35	–1.00	0.33
P – Social interaction	0.00	0.00	0.12	0.35	–1.00	0.33
Q – Resolution of problems	0.00	0.00	0.00	0.00	–	–
R – Memory	0.00	0.00	0.00	0.00	–	–
Cognitive score – Subtotal	0.00	0.00	0.12	0.35	–1.00	0.33
Total score	7.75	4.03	2.75	2.49	2.97	***0.01****

* p < 0.05, with p associated to the "t" test for independent samples.

DISCUSSION

The type of study performed – almost experimental – enables the comparison of results obtained between EG and CG with treatments, measure of results, experimental units and uses no random allocation to create comparisons in which the effects of treatments are evaluated.

The results of the experiment indicate statistically significant changes between EG and CG considering the functional abilities measured through the FIM scale in relation to transferences, general motor aspects and overall score. One concludes, therefore, that the swimming physical activity was effective to improve the physical condition, bringing motor benefits detected through the FIM scale and with direct and objective application on the functional abilities of participants from the EG. The implications of the gains on the FIM scale scores directly reflect on the independence measure of patients in their daily activities. The gains on the transference activities were clearly evidenced in improvements on the abilities of moving without help from one place to another: to move from the wheelchair to the bed or to the bathroom, from the bathroom to the shower, among others.

In turn, the motor score gains were observed in the improvement on the self-care abilities such as the dress activities: the patient improved his dressing performance both for the lower body and the upper body. Generally, the improvements presented after the swimming activity brought direct benefits on the residual motor functionality maximization, leading to an optimization of time and energy spent in the performance of their daily activities.

Although there are no studies on the effects of the swimming activity on the independence measure of patients with spinal cord injury in literature, studies on the psychological and physical effects of oriented sportive practices invariably show that these effects are beneficial[7-14]. In this context, the present study corroborates with what literature points in relation to the positive effects of the swimming activity on the functional independence.

Once the methodology of the present study foresees non-random distribution of participants, this fact has brought possible errors on the selection of participants from experimental and control groups. Probably, the motivation presented by the EG may have performed a positive effect on the performance of these participants in the evaluated abilities. In fact, the performance of the EG was significantly higher when compared to the CG. However, such variable was not exclusive of EG, once the participation of the EG was not only decided based on the motivation of the participant. Although all participants have shown interest in performing the activity proposed, some of them presented difficulties in participating in the experimental group due to work or study activities during the experimental period or due to transportation difficulties. In some of these examples, it was observed that the adhesion of the family had direct implications on the possibility of performing the given activity. However, the study would have been less influenced by variables from this nature if the sample composition had been random.

Other important results verified in the EG were the improvements observed in relation to the physical, psychological and social aspects after the participation on the experiment and that probably were result of the regular practice of the swimming activity. These aspects, in turn, are closely related to the functional independence measure of patients with spinal cord injury. Although the analysis of the beneficial effects of this practice on the improvement on the quality of life of the participants was not the objective of this study, such topic deserves to be studied in further researches.

In relation to the relevance of the instrument used, the FIM scale showed to be of easy application[30-35], however, limitations to its sensibility and reliability were observed in evaluating the quality of the movement performed as well as its omission in relation to the motivational aspects. New studies should be conducted with the objective of elaborating independence measure instruments that could be used in the rehabilitation context of patients with spinal cord injury and sensible to changes on the movement quality aspects related to improvements on the physical, psychological and social condition such as those resulting from the regular practice of physical activities.

There is no doubt that the practice of sports and recreation bring many benefits to individuals with SCI that reflect in the improvement on the performance of daily activities, in the promotion of physical and social welfare and in the reduction on the incidence of clinical complications. The rehabilitation interdisciplinary staff should encourage the participation of patients in sportive and recreational activities, emphasizing aspects such as security, entertainment, cooperation and friendship. Moreover, some patients lose interest with the rehabilitation routine and the inclusion of sports in their treatment could be suggested and well accepted for providing relief for the daily rehabilitation severity[5]. It is also important that the rehabilitation staff be aware that there is no ideal patient for such participation especially because, along with the medicine advancements, other important evolutions have occurred,

what resulted in the production of several adaptations that make the practice of many sportive modalities accessible to all.

Therefore, one could conclude that all rehabilitation programs should include the practice of sports in their programs with the objective of obtaining the benefits that these programs provide for the health of patients. The new rehabilitation paradigm[1,2] has long recommended the therapeutic sports; although one observes in practice that the valorization of the Physical Education Hospital Professor professional category has slowly increased in relation to the roll of professional who compose a real rehabilitation interdisciplinary staff.

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