PHYSIOTHERAPY AND RECREATION IN SPINAL CORD INJURY – A CASE STUDY

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Abstract

Introduction: Spinal injury is damage to the spinal cord resulting in permanent or temporary changes of normal motor, sensory and autonomic functions. Considering large choice of possibilities of recreation, many convalescents with spinal injuries can find choice of their own, but there are many patients with no interest in offered activities. Recreation for persons with spinal injuries presents challenge for patients, physiotherapists and whole rehabilitation team in deciding which recreation to choose according to patient's interest and remaining abilities. The case study on implementing recreational activity with patient after spinal injury, within the frame of their abilities, will be presented. Purpose: To increase balance, normalize muscle tone of lower extremities, and improve gait of the patient trough recreational activity of climbing on artificial rock. Methods: This paper presents case study on a patient who decided to participate in climbing on artificial rock as recreational activity after spinal injury (fracture C6-C7) caused by fall from a bicycle. He was regularly included in Bobath treatment, 5X per week with home program. The plan of training sessions was made together with kinesiologist – climbing coach. For the assessment of success of climbing training program balance was tested with Berg´s balance scale (BBS) and Time up and go test (TUGT), muscle tone was measured with Ashworth´s scale (ASW), and active range of movement of fingers (AROM) with goniometer. Training session lasted 1-2X weeks for 3 months. Results: Initial measures of BBS showed 46 points; TUGT 1.34 min; ASW 1+/2; AROM 40°, while final measurement showed results: BBS 50, TUGT measurement 0.56 min., ASW 1+/2, AROM 40°. Visible improvement in results on BBS and TUGT test speak in favor of positive influence of physical activity on static balance and gait. Conclusion: It is a known fact that physical effort encourages birth of new nerve cells, and that mental activity increases chances for survival of new neurons and their capability of acquiring new functional connections with existing network of neurons. Inclusion of persons with spinal injury into recreational activities together with physiotherapy, except psychophysical wellbeing, will also satisfy social wellbeing in the context of reintegration into society.

Key words: *tetraparesis, neurorehabilitation, sports activity.*

Introduction

A spinal cord injury can cause a complete or partial paralysis of body parts, hemodynamic instability, vegetative imbalance, and dysfunction of organs and organ systems distal to injury level (Grundy & Swain, 2002; Moslavac et al., 2012). Death caused by such injuries used to be extremely high, but today's approach to traumatised patients with rapid evacuation and transport to hospital has significantly reduced mortality. A better understanding and treatment of the injured patients have reduced transport induced spinal cord injuries as claimed by Grundy and Swain (2002). About a hundred new patients with a spinal cord injury are recorded and treated every year in the Republic of Croatia, which corresponds to the incidence of spinal cord traumatic injuries in about 20/1,000,000 people in Europe, as reported by Schnurrer-Luke-Vrbanić, Moslavac and Džidić (2012). Although a Croatian register of patients with spinal cord injury does not exist, according to the available data from HZJZ-SJZ (2017) show that in 2016 there were 296 patients with para/quadriplegia in the Zagreb County and the total of 5,476 patients in the Republic of Croatia. Statistics on people with spinal cord injury indicate that 40% of spinal cord injuries are caused by traffic accidents, about 21% by violence (weapons), 22% by falls, about 7.5% by different sports and diving into water, as reported by NSCISC (2004), while about 2% of quadri/paraplegia cases have other causes. Diving, skiing, football and riding are the most common causes of sports-related spinal cord injuries. The incidence of this type of injury is almost four times more common in men (78.2%) than in women. According to Schnurrer-Luke-Vrbanić et al. (2012) the most common age at the time of injury is on average 32.6-37.7. Consequences and complexity of the spinal cord injury require a multidisciplinary team due to a long-term care of the patient, often with persistent and severe neurological deficits or disability. Sometimes patient care is a lifelong process. Consequences can be mitigated by good patient care not only in primary care, but also in the community as claimed by Schnurrer-Luke Vrbanić et al. (2012), and by integrating the patients into everyday life. According to Petrinović (2014) sports and recreation contribute to improvement of general health condition of people with disabilities, their self-affirmation, and integration into society. Apart from numerous motor skill, sensor and other problems, disability very often results in fewer

social contacts, so recreation is necessary as a means of emphasizing the remaining skills in people with disabilities to widen their social networks. Research by Lazić and Barić (2013) showed that doing sports considerably contributed to the quality of life in 41% of subjects; it significantly contributed to the quality of life in 38% of subjects; moderately in 15%; and slightly in only 4%. Climbing is a sports activity through which a number of motor skills, such as coordination, balance, flexibility, and strength, are developed. Each sport, climbing included, has a positive effect on the immune and vascular systems, and metabolic, endocrine and hemodynamic effects have also been noticed. Almost all sports activities are connected with social contacts, and research by Velikonja, Čurić, Ožura and Jazbec (2010) indicates that doing sports is for many people an easily accessible social and communication experience.

Neurophysiotherapy methods based on principles of neuroplasticity and motor leaning provide a room for improving recovery outcomes (Barać, 2015; Grozdek Čovčić & Maček, 2011). Neuroplasticity can be considered a neural mechanism of motor recovery initiated by physiotherapy interventions as reported by Cramer et al. (2011). The physiotherapist influences specific parts of the body using specific techniques such as facilitation of the movement and leads the patient when performing a movement. The patient achieves better control over the movement through repetition (Cotman & Berchtold, 2002; Cramer et al., 2011; Kramer & Erickson, 2007).

Planning a neurophysiotherapy intervention is based on principles of motor learning and control. Learning a motor skill in this way represents an expansion of one's motor skills and acquisition of new motor programs, while neurorehabiliation represents a process of motor learning. Neurophysiotherapy for patients with a spinal cord injury includes individual and holistic approaches to each patient. Physiotherapy intervention aimed at improving participation, activity, and recovery of body structures and functions is preceded by physiotherapy evaluation setting short-term and long-term treatment goals taking into account the patient's wishes, goals and needs, as well as mitigating and aggravating factors in the patient's environment (Bilbao et al., 2003; Maček & Telebuh, 2008).

According to the International Classification of Functioning, Disability and Health (ICF) a physiotherapy report contains the patient's general identification data, information on relevant medical and social history, objective physiotherapeutic analysis of the patient's functional condition, and the patient's goals. A correct physiotherapeutic analysis is supported by relevant measurements and tests. According to the ICF the level of activity is defined as "the execution of certain tasks by a patient" and the level of participation as "participation or involvement of the patient in a life situation" reported by Rauch, Bickenbach, Reinhardt, Geyh and Stucki (2010). The initial neurological status is determined and assessment of the level and extent of the neurological damage is made by a standard spinal cord injury classification according to the American Spinal Injury Association ASIA (1984). The ASIA scale is categorised by alphabetical order: ASIA A: no sensory function and no mobility; ASIA B: sensory incomplete, no mobility; ASIA C: partially preserved sensory function and mobility – function of specific muscles under the lesion level is assessed, over half of the assessed muscles have under 3 (0-5) level of functionality; ASIA D: partially preserved sensory function and mobility – function of specific muscles under the lesion level is assesses, over half of the assessed muscles have over 3 (0-5) level of functionality; and ASIA E: normal sensory function and mobility. According to Read, Sisto and Ditunno (2008) a number of tests are used for a more complete physiotherapy assessment and assistance in planning the physiotherapy intervention, depending on the affinities of the health professional conducting the testing, and on the level and complexity of the injury.

The most common tests are: the Barthell Index (BI) and the Functional Independence Measure (FIM) to assess the patient's independence; the Ashworth Scale (AS) to assess spasticity; the Berg Balance Scale (BBS), the Anterior Reach Test (ART), and the Lateral Reach Test (LRT) for balance and fall risk assessment; the Timed Up and Go Test (TUG), the 10-Meter Walk Test (10MWT), the 6-Minute Walk Test (6MWT), and the 2-Minute Walk Test (2MWT) for gait and fall risk assessment; and a specially designed test for the abovementioned Spinal Cord Independence Measure III (SCIM III) group which is a validated instrument for measuring the patient's functional abilities at the beginning and end of the rehabilitation as claimed by Moslavac et al. (2012). It is necessary to put the patient and his/her family in the centre of the rehabilitation process. The basis of the transdisciplinary approach is mutual respect and exchange of professional opinions between health professionals of various specialties. According to Batelić Dragić (2014) besides understanding the symptoms, course of recovery, and consequences of the injury, physiotherapy interventions have to be adapted to the patient's needs, wishes and affinities, and must fully involve the patients in the decision-making process and choice on the rehabilitation course.

Problem and aim

It is necessary to choose recreational activities for younger and working people after they have suffered a spinal injury according to each individual's interests, respecting his wishes and affinities, but also their remaining abilities. The goal of this research paper is to establish if artificial rock climbing as a recreational activity can improve balance, normalize lower limb tone, and improve gait function in patients with a spinal injury.

Methods

Table 1. Patient assessment form.

Name and surname: A.K.		**Entry number; Date:** 2/7/2012.	
Occupation: Electronic engineer	**Age:** 1983	**Gender:** M	**Hobbies:** Free climbing, hiking, cross-country cycling
Medical diagnosis: Fractura vertebrae C6 et C7 cum luxatione vert. C6/C7; Tetraplegia ASIA A; Commotio cerebri			
Participation in activities: The patient uses the active wheelchair by himself; partially independent in performing ADL; hands are flexed; gross motor skills partially preserved; fine motor skills weaker; transfers from wheelchair to bed independently; incontinent; uses the external catheter;			
Structure and function analysis: The patient transfers from the wheelchair to bed independently with the extensive use of hands (in a flexion pattern) and minimum support of the feet. He moves in bed (using his arms) and turns into the lateral and prone positions independently. There is a complete analgesia and anaesthesia in lower extremities and selective movements are uncoordinated. There is an extensor spasm of both extremities. The patient maintains balance in the sitting position, but tires easily. He performs the seated trunk rotation using his arms due to balance problems. There is immobility in the pelvis and the trunk because of the increased trunk extensor tone and inadequate abdominal muscle activity. He stands up with the help of one person and a walker. He walks with the key pelvis point facilitated watching his legs (even when not watching the knee flexes spontaneously). He cannot stand without using his arms. The feet have a reduced selective movement. The left hand and fingers, dominant in ADL, are slightly to moderately hypertonic and have a better function than the right hand. The right hand and fingers have moderately to extremely hypertonic flexor muscles while the left hand has moderately hypertonic flexor muscles. Gross motor skills of the upper extremities are partially preserved, whereas fine motor skills are weaker. **Tests:** ASW of lower extremities 3+; ASW of fingers - left hand 2, right hand 2+/3; AROM of foot dorsiflexion – right 5°, left 5°; BBC 7/56; FIM 62/119, SCIM III 42/100.			
Physiotherapy goals: Physiotherapy goals: increase trunk and pelvis mobility; increase balance in the sitting position and when standing; reduce lower extremity tone; reduce the muscle tone in the hands; improve arm and hand function; increase step length.			
Physiotherapy plan: Treatment based on the Bobath concept.			
Treatment evaluation: 13/9/2013: Adequate mobility of the trunk and the pelvis; lower extremity tone low to moderately increased ASW 1+/2; normal selective foot movements within; the patient can walk 50 meters on his own using crutches, but he still has to watch movements of his legs and feet when walking; sensitivity remains the same; hands slightly hypertonic and more functional in ADL, but with reduced GMS. The patient has returned to work. Limited use of the wheelchair recommended and walking without crutches as a part of the Home Program, as well as engaging in recreational activities. **Tests:** ASW of lower extremities 1+/2; ASW of the fingers - left hand 0/1, right hand 1; AROM of foot dorsiflexion - right foot 20°, left foot 20°; BBC 46/56; FIM 99/119, SCIM III 61/100.			

One subject, aged 33, participated in the research. He suffered a cervical spine fracture at the level of C6-C7 following a bicycle accident 5 years ago (Table 1). Status praesens: mildly/moderately increased lower extremity tone; balance problems and balance related reactions, such as an extensor spasm, when getting up; hands in a flexion pattern; reduced selective finger extension (AROM 40°); lack of sensitivity below the mamillae; drives a custom-made car; works full time; uses a wheelchair most of the day except for shorter distances when he uses 2 crutches; incontinent, uses the external catheter. The study was conducted over the period of 3 months – from September to December 2013 - and included a neurophysiotherapy treatment, a rock climbing training program, and exercises as part of a home program. The patient was treated by a licensed Bobath therapist undergoing neurophysiotherapy – a 60-minute Bobath treatment 5 times a week; he had a 90-minute rock climbing training on an indoor artificial rock 1-2 times a week under the guidance of a kinesiologist, a climbing coach; the home program included 30-minute exercises daily which the patient did on his own following the physiotherapist and kinesiologist's instructions. The effectiveness of the climbing training was measured by testing the balance by the Berg Balance Scale (BBS), the fall risk by the Time Up and Go Test (TUGT), the tone by the Ashworth Scale (ASW), and the active range of finger extension motion (AROM) by a goniometer.

Results

Results of the study showed a reduced fall risk. The difference between the initial and the final TUGT measurements is 0.38 seconds while lower extremity tone remained unchanged, according to the Ashworth Scale 1+/2 (Table 2, Graph 1). Results of balance measurements indicated a progress (there was a 4 point difference between the initial and the final BBC measurements) while the active range of motion remained unchanged, active finger extension being 40° (Table 2, Graph 2).

Table 2. Results of initial and final measurements.

	TUGT	ASW	BBC	AROM
Initial measurements	1.34	1+/2	46	40°
Final measurements	0.56	1+/2	50	40°
Difference in initial and final measurements	0.38	0	4	0

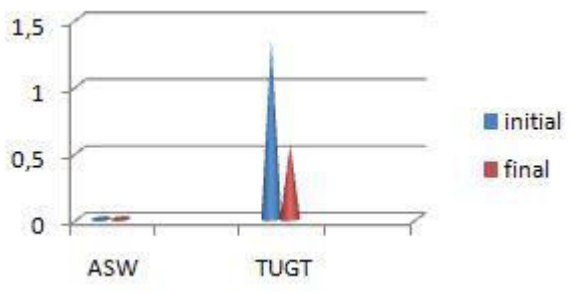

Figure 1. Results of tone measurements (ASW) and fall risk (TUGT), initial and final measurements.

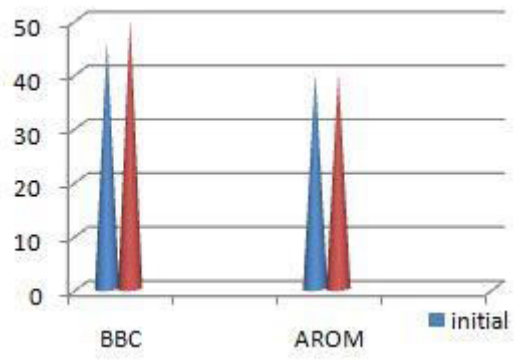

Figure 2. Results of balance measurements (BBC) and active range of finger extension (AROM), initial and final measurements.

Discussion and conclusion

The nature of climbing activity requires that athletes have good physical abilities reported by Gallotta at al. (2015). And other studies confirm the development and improvement of strength, balance, motor skills and mental control in climbing (Giles, Rhodes & Taunton, 2006; Hodgson et al., 2009; Morrison & Schöffl, 2007). Research by Christensen, Jensen, Voigt, Nielsen & Lorentzen (2017) has shown that climbing is a good way to maintain physical activity in children with CP. The authors assume that better motor abilities result from the corneal and muscular synchronization resulting in a more efficient regeneration of motor units. This case study illustrates a research on artificial rock climbing the patient with a spinal cord injury chose as a recreational activity. The activity showed positive results and improved balance (the difference between the initial and the final BBC measurements was 4 points). Although the difference between the initial and the final measurements is small, the subject achieved positive results in the most challenging aspects of the measured balance: standing without support with eyes closed; standing with outstretched arms reaching a particular point with one hand; alternating placing a foot on the step in a standing position and standing on one leg. The objectively improved balance resulted in a subjectively better balance while walking thus making the patient feel safer and more satisfied.

Time Up and Go Test used for measuring fall risk and walking speed also showed a positive result, i.e. a reduced fall risk (the difference between the initial and the final measurements was 0.38 seconds). Although the result under 20 seconds indicates a low fall risk and fully independent mobility, we believe that the result shows a positive trend of reducing fall risk and improving walking function (better balance and safety) since the patient uses the wheelchair for longer distances (over 100 meters) and 2 crutches for shorter ones. Results of the initial and the final lower extremity tone measurements remained unchanged (ASW 1+/2) although the patient's subjective perception indicated a reduced muscle tone after the climbing training and a better coordination of the selective leg movement while walking. Taking into account the problem of the spinal cord injury spasm we believe that even a short-term effect of the reduced spasticity is beneficial for patients. Active range of finger extension movement did not change between the initial and final measurements (AROM 40°).

The cause possibly lies in the flexion of the hand during the climb with the considerable use of concentric finger flexion without the great need for a full extension of the fingers when the place of the grip changed. We are, therefore, inclined to believe that it is the reason why the initial and final measurement results of active range of finger extension remained unchanged. In conclusion, we would like to point out that daily physiotherapy program based on the Bobath concept enabled the patient to achieve a good postural and extremity motor control and a normal range of motion and alignment of joint and muscle structures while the climbing training on the artificial rock provided increased strength of leg muscles, shoulder girdle and arms, as well as trunk and pelvis which are the basis for a better balance. Neither motivation nor the subjective sense of pleasure when engaged in a recreational activity can be neglected, in this case climbing which the patient enjoyed before the accident. Cooperation of the physiotherapist and the kinesiologist was also beneficial for the patient. This research could become a research platform for further study on a larger sample with a specific assessment of other spinal cord injury issues, as well as a study of the quality of life, life satisfaction and integration in the patient community.

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FIZIOTERAPIJA I REKREACIJA KOD SPINALNIH OZLJEDA – PRIKAZ SLUČAJA

Sažetak

Uvod: Spinalna ozljeda je oštećenje leđne moždine koje rezultira njenim trajnim ili privremenim promjenama normalnih motoričkih, senzoričkih i autonomnih funkcija. Rekreacija za osobe sa spinalnim ozljedama predstavlja izazov za bolesnika, fizioterapeuta i cijeli rehabilitacijski tim u odluci koju rekreaciju odabrati po interesu i preostalim sposobnostima bolesnika. U ovom radu dati će se prikaz bolesnika nakon spinalne ozljede u provođenju rekreativne aktivnosti u okviru njegove sposobnosti odnosno onesposobljenosti. Cilj rada: Kroz rekreaciju penjanja na umjetnoj stijeni poboljšati balans bolesnika, normalizirati tonus donjih ekstremiteta, i poboljšati funkciju hoda. Metode rada: U radu je prikazan slučaj osobe nakon spinalne ozljede (fraktura C6-C7) koja se je odlučila baviti penjanjem na umjetnoj stijeni kao rekreativnom aktivnosti nakon ozljede pada s bicikla. Redovito je bio uključen u Bobath tretman, 5X tjedno uz home program. Uz timski rad s kineziologom – trenerom penjanja napravljen je plan treninga penjanja. Kao provjera uspješnosti treninga penjanja provjerena je ravnoteža Berg balans skalom (BBS) i Time up and go test (TUGT), tonus je mjeren Ashworth skalom (ASW), a aktivni opseg pokreta prstiju (AROM) goniometrom. Trening se izvodio 1-2X tjedno, 3 mjeseca. Rezultati: Inicijalno mjerenje BBS je pokazalo 46 bodova; TUGT 1,34 min ; ASW 1+/2; AROM 40 °, dok je finalno mjerenje dalo sljedeće rezultate: BBS 50, TUGT mjerenje 0,56 min. , ASW 1+/2, AROM 40°. Vidljivo je poboljšanje rezultata u BBS i TUGT testu što govori u prilog pozitivnog utjecaja tjelesne aktivnosti na statički i dinamički balans te funkciju hoda. Zaključak: Poznato je da tjelesni napori potiču rađanje novih živčanih stanica, a mentalna aktivnost povećava izglede za preživljavanje novih neurona i sposobnost uspostavljanja funkcionalnih spona s postojećom mrežom neurona. Uključivanje osoba sa spinalnom ozljedom u rekreativne aktivnosti uz fizioterapiju, osim psihofizičke dobrobiti, zadovoljit će i socijalnu dobrobit u okviru reintegracije u društvo.

Ključne riječi: *tetrapareza, neurorehabilitacija, sportske aktivnosti.*

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