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Added Effect of Aquatic Therapy on Functional Performance in Incomplete Cervical Spinal Cord Injury Level: A Case Study

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Abstract

Spinal cord injury (SCI) is a traumatic event that is debilitating and results in permanent motor and sensory deficits. The severity and degree of permanence of the motor and/or sensory deficits is dependent upon the location and extent of damage to the spinal cord tissue. This case report describes an aquatic therapy program and the outcome for 19-year-old male with incomplete spinal cord injury. Self-care, functional mobility and walking parameters examined using American Spinal Cord Injury Association (ASIA), Spinal Cord Independence Measures (SCIM) and Walking Index Spinal Cord Injury (WISCI). The patient received aquatic therapy thrice in a week for one-hour session, for 6 weeks. The intervention included aquatic activities designed to improve gross motor skills for self-care, functional mobility and gait parameters. Spinal cord independence measure score improved from 32 to 43. Patient showed drastic improvement in Walking Index, where he was able to walk 10 meters in walking frame with no orthosis and no assistance. The outcomes of this case report demonstrate the successful improvement of self-care, functional mobility and walking parameters in 19-year-old patient with SCI. The study provides clinical information for therapists utilizing aquatic therapy as a modality for Spinal Cord Injury patients.

Keywords: Aquatic therapy; Rehabilitation; Spinal cord injury

Introduction

Spinal cord injury (SCI) is a traumatic event that is debilitating and results in permanent motor and sensory deficits. The severity and degree of permanence of the motor and/or sensory deficits is dependent upon the location and extent of damage to the spinal cord tissue [1]. In the Indian setup, as in most developing countries, very little is known about the exact incidence of SCI, as there is no national database. In India, approximately 1.5 million people live with SCI, 20,000 new cases of SCI added every year and 60-70% of them are illiterate, poor villagers [2]. Majority of them are males in the age group of 16-30 years, signifying higher incidence in young and productive population of the society. Furthermore, epidemiological and demographic data of SCI in Indian scenario are different from western countries with major cause being fall and not RTA [3].

A transection through the spinal cord results in a complete interruption or separation between spinal segments. It causes total loss of motor and sensory function, which is a model of complete SCI [4]. The severity and degree of permanence of the motor and/or sensory deficits, is dependent upon the location and extent of damage to the spinal cord tissue. The neurologic damage that results from trauma is only a part of it due to the initial damage. Within the former hours of trauma, a process of progressive tissue destruction begins with the cord, which may significantly extend the area of neuronal damage. This further can lead to ischemia, demyelination, oedema and necrosis of the spinal cord. With subsequent time the necrotic area of the spinal cord undergoes resorption and is replaced by scar tissue or formation of cysts or cavities [5]. SCI further culminates in glial scarring, a multifactorial process that involves reactive astrocytes, glial progenitors, microglia and macrophages, fibroblasts and Schwann cells [6,7]. In contrast to these destructive events, commonly observed pathological features indicate certain spontaneous repair after SCI such as axonal sprouting and generation of new pre-cursor cells [8]. After SCI, new spinal circuits can bypass the lesion, including sprouting of injured corticospinal axons onto spared, long descending propriospinal tracts that increase connectivity with lumbar motor neurons. Cortical sensorimotor areas can functionally rearrange and, at the subcortical level, the rubrospinal system can reorganize and compensate for much of the function lost after corticospinal injury [9,10].

According to WHO, many of the consequences associated with spinal cord injury do not result from the condition itself, but from inadequate medical care and rehabilitation services, and from barriers in the physical, social and policy environments the treatment and rehabilitation process for trauma caused by SCI is long, expensive and exhausting [11]. Treatment of patients with spinal cord injury is an ongoing process for many years and starts shortly after the injury with acute care and early surgical interventions; thereafter, sensory, motor and autonomic dysfunction treatment in the chronic phase and finally, life-long treatment in the home environment [12]. Furthermore, rehabilitation often combines multiple treatments that are prescribed by multiple health care professionals. There, however, remain controversial areas surrounding certain management strategies for the treatment of SCI, including the use of corticosteroids such as methylprednisolone sodium succinate (MPSS), the optimal timing of surgical intervention, the type and timing of anticoagulation prophylaxis, the role of magnetic resonance imaging (MRI), and the type and timing of rehabilitation. This lack of consensus has prevented the standardization of care across treatment centres and across the various disciplines that encounter patients with SCI [13].

There are many rehabilitation services evolving which are practiced to improve the functional performances of a spinal cord injury patient. Aquatic therapy has long been perceived as an effective, yet less utilised, therapeutic modality. Hydrotherapy provides the following alternative options to land-based exercises (1) a different rehabilitative environment, (2) the prescription of different upper limb and core exercises and (3) the opportunities for group and/or individual rehabilitation sessions with the exercise therapist (thereby

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increasing social interaction) [14]. In adjunct with physical exercises, aquatic therapy can be used to analyse added effect. Aquatic therapy helps in improving flexibility, balance, coordination, building muscles strength and endurance, enhancing aerobic capacity, assisting with gait locomotion reducing stress and promoting relaxation at the body function level. Water's natural viscosity is an important property along with buoyancy, which is provided by the water to assists in supporting weight of the patient. Hydrostatic pressure is one of the best benefit of aquatic therapy [15]. There is weak evidence supporting aquatic exercise training to improve functional performance among young adults with spinal cord injury [16]. Hence the need arises to carry out the study to see the effect of aquatic therapy on SCI, and it becomes necessary to evaluate the functional outcomes with respect to spinal cord injury.

Case Description

A 19-year-old man had suffered an incomplete SCI (C6, ASIA C) secondary to a fall from camel and then kicked by camel on his face 1 year prior to this study. He was unable to move his hands and legs thereafter. He immediately taken to the hospital where CT cervical spine was done which showed fracture of cervical spine C5-C6. Patient was then stabilised and shifted to Mumbai and readmitted to NHSS for further management. Next day he was operated and C5 corpectomy with C4- C6 anterior cervical decompression and plating was done. After the operation, he was shifted to ICU. He was immobilised and put on ventilator support. Patient was intubated next day to protect his airway. Physiotherapy was started post-surgery. Patient was given Passive movements and bed mobility exercises. He was taken on tilt table and after few days, he could attain 90° of elevation. Power improved gradually in all limbs. During his stay in ICU, his sedation tapered off and intermittent fever spike. Patient had developed abdominal distention and constipation; on proper treatment, he could pass stools. He was further shifted to general ward. He was later on brought home and physiotherapy was started in the home environment. Physiotherapy included bed mobility exercises, strengthening exercises, mat activities, and gait training. Patient was walking without orthosis using a walker with two people holding by his sides. Loading response was on toes, during mid swing no pelvic rotation was noted, hip-knee flexion was reduced and hips used to go into slight adduction. During single limb support, weight is completely on forefoot. The two helpers controlled trunk sway. During Swing phase push off was absent. Patient then started aquatic therapy from the month of November.

During the Aquatic Therapy program, the patient continued with his land based physical therapy for three times in a week (single session lasting for approximate one hour). The primary goal for the patient was he would become as independent and confident as possible in his self-care, functional mobility and walking as typical as he can.

Examination

Prior to initiating the aquatic program, a comprehensive physical therapy examination done by 1st author. Screening of ASIA scale done. Active and Passive ROM was measured where lower limb joints showed restriction throughout. Musculoskeletal system review indicated weakness throughout. Sensory system review indicated no temperature sense below Xephesternum while other senses like pinprick and touch was present throughout. Deep tendon reflexes were exaggerated. He had slow and poor protective and equilibrium reactions from sitting position.

He was unable to take a step without any assistance when balance was disturbed.

He presented with activity limitations in Supine to Sit, sit to stand, walking, climbing stairs and self-care. The patient was able to walk indoor with walking frame with orthotics and maximum assistance of two people at trunk. He had difficulty to ascend and descend the stairs. These activity limitations diminish his ability to participate in community activities.

Two standardized outcome measures used, the Spinal Cord Independence Measure (SCIM) and Walking index (WISC).

Intervention

The patient received aquatic therapy thrice per week for one-hour sessions, over a period of 6 weeks. The aquatic therapy provided in a 20 feet by 30 feet therapy pool, where the water depth was 3 feet to 6 feet. It was club outdoor pool where water temperature was maintained at 29 degrees Celsius. The water level maintained between the patient's waist and the nipple line.

Each session consisted of a warm up period, aquatic exercises (Table 1) followed by a cool down period. The warm up and cool down period performed in the pool and included low intensity exercises. The therapist monitored the patient for sign of fatigue, discomfort, pain and soreness. Rest intervals provided based on the patients request and the therapist's observation. Each session included one or two short 1 or 2 minutes break in the middle of one-hour session.

Breathing exercises	• Blowing into the water using tubes to make bubbles, egg flips and balls on the surface of the water. • Singing
Flexibility	• Extremities and trunk elongation activities such as lying supine using a flotation device as the therapist sways the patient from side to side.
Floatation-resisted exercises	• Moving while holding a flotation noodle. • Pushing floatation noodle with upper and lower limbs.
Strengthening activities	• Moving the body part(s) against water turbulence toward or away from the surface of the water. • Dynamic balance from squatting or standing and maintaining by performing single-legged stance, and weight-shifting activities.
Balance activities	• Reaching in different directions to catch a ball, throwing a ball. • Picking up a ring from the therapist's hand in the water or placed on the floor of the pool to promote weight shifting and loading of the lower extremities • Marching activities that focused on maintaining an upright trunk posture during single-leg stance, and strengthening of the hip and knee flexors and ankle-dorsiflexors during swim.
Walking activities	• Stepping activities • Walking activities at various speeds and water depth. Walking over an obstacle course, and changing directions. • Transitions • Sit-to-stand and controlled stand-to-sit. • Squat to stand activities

Table 1: Summary of aquatic exercises.

Results

The patient underwent intensive physiotherapy in his home environment as well as enrolled himself for aquatic therapy. According to his pre Spinal cord independence measure scale, his overall score was 32. Post aquatic therapy, measurements were repeated in which the score improved to 43. Patient showed drastic improvement in indoor and outdoor mobility. Furthermore, post aquatic therapy, he was able to perform his functional activities like bringing food to mouth and hold a cup with fluid without any assistance. His activities of daily living like washing himself using a soap required partial assistance while he needed maximum assistance to dry himself and dressing up. He was able to do brushing teeth, combing hair with less assistance. He requires full assistance for using toilet. He needed maximum assistance to operate manual wheelchair and while performing transfer activities such as getting in and out of car requires partial assistance.

Discussion

In the present report, we described a patient with injuries to the spinal cord due to a fall. This is an alarming condition where the most active human resource becoming severely disabled. This affects their day-to-day life, including medical treatment due to financial constraints and non-availability of caretaker.

This patient was classified as ASIA- C prior to therapy. His neurological level of injury was determined as C-6 according to the American Spinal Injury Association Impairment Scale. Sensory examination like touch and pin prick sensation were preserved below the level of injury. The manual muscle test showed less than half of key muscle function below the single neurological level having muscle power >/3 with poor trunk control. Deep tendon reflexes were exaggerated and muscle tones of bilateral upper and lower extremities were spastic. His bowel and bladder functions were present. We described a patient with spinal cord injury due to a fall. With SCI, the once intact neuronal circuits undergo extensive reorganization in which inactivity leads to their pruning and a return of activity strengthens synaptic connections [17]. The aquatic environment directly benefited and improved his residual motor functions. The physical properties of water, make it a perfect medium for increasing patients' functional gains within a therapy program as it facilitates a variety of therapeutic techniques, including passive range of motion (PROM), active range of motion (AROM), progressive resistive exercises (PRE's), and goal-based activity.

Post therapy, there was improvement in his lower limbs muscle strength. Moreover, trunk control also fairly improved. Further, it was observed that gait parameters like cadence and step length also increased. These findings suggested that there is a diverse collection of evidence indicating the efficacy of aquatic therapy as a rehabilitative intervention for patients with SCI. The aquatic environment provides a less restrictive buoyant lift, viscous resistance to movements and cutaneous dampening of sensations that may trigger spasms [18]. It attempts to trigger muscles below the level of the lesion, "with the goal of retraining the nervous system to recover a specific motor task."

People with incomplete SCIs have reduced balance ability, are prone to falling, and have difficulty advancing and bearing weight on their lower limbs. It takes several practice sessions for a patient to learn the skills [19]. Effect of water not only helps in gait training but also helps improve core strength and motor strategies. Researchers also reported that SCI patient energy expenditure was lower during underwater walking as compared to land-based walking at specific speeds, which allowed them to walk for longer period [20]. To support our findings a study done by Recio et al. shows that aquatic therapy is highly effective in promoting overall recovery from SCI [18].

After 6 weeks' post- intervention follow up after 2 weeks was done which showed sustained improvements in gait. Patient was able to walk up to 10 meters without orthotics with a walker without any complains. However, a longer follow up is required to record the further findings.

Hydrotherapy aids in reducing PWSCI muscle spasticity and cardio metabolic risk profiles, while favourably enhancing underwater gait kinematics and cardiorespiratory capacity. However, more RCT should be undertaken to increase the present body of knowledge.

Conclusion

We conclude that introducing aquatic therapy as a treatment strategy helps to improve functional performance in incomplete cervical spinal cord injury patients. However, further research is needed with a larger sample size to generalize the effect.

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