Case Report

Influence of sensorimotor adaptation and learning process for rehabilitation on the functional mobility of a patient with traumatic brain injury: A case report

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Abstract

This case report reveals the implementation of sensorimotor adaptation and learning process for rehabilitation in a patient with traumatic brain injury to achieve optimum recovery which is permanent in nature in compliance to the disability rating scale. A twenty two year old gentleman who had a history of fall was diagnosed as having subarachnoid hemorrhage along with diffuse axonal injury of the brain and bilateral lung contusion with pneumothorax. He underwent a total of ten months of sensorimotor adaptation and learning process for rehabilitation, which achieved functional mobility with a walker.

Introduction

Human movement control is very complex in which over 640 muscles and numerous sensations act together to make smooth and accurate movements with ease.1 Even in the face of constantly changing demands, we only become aware of the ease of making smooth and accurate movements when there is some compromise at the central nervous system.1

‘Adaptation’ occurs for all types of movement whether it is reaching, walking, balancing or eye movements.1 Adaptation of a particular movement can only occur by practicing that movement over and over. Motor learning is the direct result of practice and is highly dependent on sensory information and feedback processes.2 Hence here comes ‘learning’ into the picture, which means the formation of new motor patterns that occur with long term practice and are permanent. It is thought that the individuals may store many learned motor plans or calibrations that allow efficient switching from one to another, but solely motor adaptation and learning approach cannot achieve our goal, as we, the therapists, need the patients to be aware of what is happening in and around. Hence ‘sensory restoration’ plays an important role to provide information for the nervous system by replacing or augmenting the sensory pathways that are dysfunctional as a result of disease or injury.1

This report focused on the implementation of both sensory and motor training over and over so as to achieve optimum functional recovery of both the sensory and motor functions which is permanent in nature in a patient with traumatic brain injury in compliance to the disability rating scale (DRS).3

Case report

A twenty two years old gentleman was airlifted from a hospital in Muscat, Oman to the intensive care unit of National Heart Institute, New Delhi, India in drowsy state with tracheostomy tube, nasogastric tube and foley’s catheter in situ. History revealed that the patient fell from ten feet height in the engine room of the ship; he was then shifted to a nearby hospital in Muscat in an unconscious state, where he was diagnosed as having subarachnoid hemorrhage with diffuse axonal injury of the brain, and bilateral lung contusion with pneumothorax. Subarachnoid hemorrhage was controlled and the patient was later tracheostomized. Theretofore the patient was shifted to our institute for further rehabilitation.

All the procedures performed in this case report are in accordance with the ethical standards. The patient’s parents have given their consent for the patient’s images and other clinical information to be reported in the journal and they understand that the patient’s privacy and confidentiality will be maintained all throughout, but anonymity cannot be guaranteed.

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On examination the patient had a Glasgow coma scale (GCS) score of 6T/10 (tracheostomy tube in situ) and was maintaining vitals at room air. His chest expansion was reduced and gag reflex was poor. There was grade IV spasticity (Modified Asworth Scale) with impaired superficial and deep cortical sensations; all tendon reflexes were exaggerated for bilateral upper and lower limbs.

We took DRS as our tool to set our aims and to deliver our therapy accordingly; after achieving the set goals, DRS was reassessed to make new goals. All the techniques incorporated in this case report were made to train over and over so as to make the patient more aware and ensure that the pattern is learnt in a permanent manner. DRS at Day 1 was 15/19. Physiotherapy intervention was started twice daily from the very first day within the intensive care unit with chest clearance activities viz. suctioning via tracheostomy as well as oral, along with passive range of motion exercises, positioning and stretching of bilateral upper and lower limbs. Orthotic devices such as elbow braces, ankle-foot orthosis and cock-up splint (bilaterally) were given to prevent deformities.

In the next five to seven days after regaining full consciousness (GCS 8T/10; DRS 19/19), rehabilitation protocol with sensorimotor adaptation and learning approach was applied in order to augment the sensory pathways and promote motor learning and eventually help form permanent movement patterns. It was started with facilitation and inhibition techniques to achieve sensory restoration at first for proprioception following passive bed mobility. In the progressive month secretions started getting clearer, hence frequency of suctioning was decreased along with increase in active assisted exercises which include bridging, rolling and side sitting and passive wheelchair with a neck support and pillows supporting trunk and limbs (Fig. 1).

| Time duration during rehabilitation | DRS score | GCS score |
|------------------------------------|-----------|-----------|
| First day                           | 15/19     | 6T/10     |
| Next five to seven days            | 19/19     | 8T/10     |
| After two months                    | 13/19     | 13/15     |
| Following two and half months      | 11/19     | 13/15     |
| Following month                     | 10/19     | 13/15     |
| After seven months of rehabilitation| 07/19     | 13/15     |

DRS: disability rating scale; GCS: Glasgow coma scale.

Fig. 1. Passive wheelchair mobilization with pillow and neck support.

Fig. 2. Independent sitting, strength training on multigym and weight shifting exercises in standing position.
After two months of rehabilitation, the patient was introduced to passive standing in a standing frame; after gaining a better trunk control (DRS 13/19), kneeling with manual support from two therapists was started gradually, followed by active-assisted sit to stand position. Reaching activities with gym ball were introduced then. Training for dysphasia from semi solid to solid followed by liquid was given, leading to removal of nasogastric tube. Decannulation training was also started with closed obturator bulb which gradually led to removal of tracheostomy tube, and thereafter speech therapy was started with GCS at 13/15.

Optimum restoration of trunk control in the following two and a half months (DRS 11/19) obtained independent sitting. Frenkels coordination exercises in supine and sitting were started thereafter along with semi-active wheelchair training for the outreach mobility of the patient.

In the following month (DRS 10/19) strength training for bilateral upper and lower limbs was started on a multi-gym. Thereafter walking with two therapists support was introduced in rehabilitation and shortly independent standing with a walker was achieved. Due to progressive improvement at lower trunk strength with weight shifting, frenkels coordination activities in standing and quadruped position were introduced, which brought about independent walking with a walker. Gait training with a walker was started after seven months of rehabilitation to refine gait pattern (DRS 07/19, Fig. 2). The Progression seen in DRS score and GCS score in accordance with time duration of rehabilitation has been shown in Table 1.

A total duration of ten months of rehabilitation was done and the patient achieved functional mobility with a walker. After that the patient was shifted back to his hometown with a plan and advice on a proper home exercise program. Regular follow-ups were taken on an interval of six months which revealed a better independent functional mobility and walking with single person support (Fig. 3).

Discussion

In this case report a traumatic brain injury patient was introduced to sensorimotor adaptation and learning rehabilitation program which help achieve the optimal functional mobility. We have found that repeated adaptation with sensory integration can help learn new motor patterns that are permanent in nature.

Hence as a physical therapist and rehabilitation professionals we would like to incorporate those approaches into our rehabilitation protocol which can bring an optimal functional outcome on a more permanent basis in such patients.

This case report suggests that the motor adaptation and learning with sensory restoration is the prime process required to control human motor system and also plays an important role in achieving the optimal functional mobility.

This approach is less understood but might reflect a vital approach to alter movement patterns on a more permanent basis if it is explored more.

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References

1. Bastian AJ. Understanding sensorimotor adaptation and learning for rehabilitation. Curr Opin Neurol. 2008;21:628–633.
2. O’Sullivan SB. Strategies to improve motor function. In: O’Sullivan SB, Schmitz TJ, eds. Physical Rehabilitation. 5th ed. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd; 2007:474.
3. Fulk GD. DRS (disability rating scale). Traumatic Brain Injury. In: O’Sullivan SB, Schmitz TJ, eds. Physical Rehabilitation. 5th ed. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd; 2007:902.
4. Gregson JM, Leathley M, Moore AP, et al. Reliability of the Tone Assessment Scale and the modified Ashworth scale as clinical tools for assessing poststroke spasticity. Arch Phys Med Rehabil. 1999;80:1013–1016.