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Case Report

Effect of Strength and Balance Intervention in Improving Balance, Gait and Function in Traumatic Brain Injury: A Case Report

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ABSTRACT

Background: Traumatic brain injury is a common condition that affects millions of people every year. Many of them have balance impairments that affect them functionally, physically, and socially. The purpose of this case study was to document outcomes after strengthening and balancing interventions in a child after traumatic brain injury. Two years after sustaining an injury post a fall, a 10 year-old boy participated in a rehabilitation program with the goal of acquiring the ability to walk properly. On initial evaluation, the individual had significant weakness, impaired standing balance and gait abnormalities.
Content: The boy was treated thrice a week for 6 weeks with strengthening and balancing interventions. The outcome measures were functional independence measure (FIM), berg balance scale (BBS), computer dynamography (CDG) for gait parameters.
Conclusion: By using above mentioned protocols, we got satisfactory results which are indicated through the improved scores in following outcome measures & this proves that exercise regime which we have used in this case may be effective in improving balance, muscle strength , gait pattern & functional independence & thereby the quality of life of TBI survivors.

Key words: traumatic brain injury, berg balance scale, strength training, functional independence scale, computer dynamograph.

INTRODUCTION

Traumatic brain injury (TBI) is a leading cause of morbidity, mortality, disability and socioeconomic losses in India and other developing countries. It is estimated that nearly 1.5 to 2 million persons are injured and 1 million succumb to death every year in India. Road traffic injuries are the leading cause (60%) of TBIs followed by falls (20%-25%) and violence (10%). Alcohol involvement is known to be present among 15%-20% of TBIs at the time of injury. The rehabilitation needs of brain injured persons are significantly high and increasing from year to year. India and other developing countries face the major challenges of prevention, pre-hospital care and rehabilitation in their rapidly changing environments to reduce the burden of TBIs. (Gururaj, 2002). According to the Brain

Injury Association of America, (1986) a "Traumatic brain injury (TBI) is an insult to the brain, not of a degenerative or congenital nature but caused by an external physical force, that may produce a diminished or altered state of consciousness, which results in an impairment of cognitive abilities or physical functioning. It can also result in the disturbance of behavioral or emotional functioning. These impairments may be either temporary or permanent and cause partial or complete functional disability or psychosocial maladjustment. Approximately 72% of these injuries are mild, 8% are moderate in severity, and 8% are considered severe.

The forces inflicted on the head in TBI produce a complex mixture of diffuse and focal lesions within the brain. Focal injuries are most commonly seen in the frontal and temporal lobes, but can occur anywhere. Diffuse axonal injury (DAI) most commonly seen as multiple punctuate subcortical lesions in and around the corpus callosum and deep white matter and/or as intraventricular haemorrhages. The most consistent effect of diffuse brain damage, even when mild, is the presence of altered consciousness. The depth and duration of coma provide the best guide to the severity of the diffuse damage (Sandell et al.1998). As stated by Olver (1996), long-term studies of recovery from TBI show ongoing improvements for at least 2–5 years after injury.

Symptoms of impaired balance and altered coordination have been particularly troublesome in TBI patients, with as many as 30% of patients complaining of these problems after TBI. (Gurr, 2001; Mrazik et al., 2000; Cicerone,1995)

Newton (1995) and Geurts (1999) investigated postural sway during quiet standing or during standing with altered sensory inputs and found that persons with TBI often have an increased reliance on visual input and tend to sway more (in both the anteroposterior [AP] and mediolateral [ML] directions) than control subjects who are without neurologic dysfunction. Evaluation in more dynamic settings, or in association with other symptomatic and psychometric assessments, has been limited.

Impairments from TBI are broad, nearly 30% of patients report impaired balance (Basford et al., 2003) as well as limitations in motor function including gait problems (Marshall et al., 2007). Addressing gait and balance problems presents a significant challenge to the rehabilitation and recovery of patients with TBI because it is generally not known what therapies are effective. There is great variability in therapeutic methods used for treatment, although they often similarly involve a comprehensive interdisciplinary team, and the employment of techniques often differs by therapist (Cullen et al., 2007; Hellweg, 2008)

Unfortunately, the state of research in gait and balance rehabilitation for patients with TBI lags behind that for patients with other neurologic impairments such as stroke and cerebral palsy as reported by McFadyen et al., 2009.

Thus, the purpose of this study was to investigate the efficacy or effectiveness of balance and strengthening exercise to improve balance, gait and functional independence in TBI patient who was assumed to have the potential to ambulate independently.

CASE REPORT

A 10 year old boy, student of 3rd standard was apparently alright before sixth June 2011, when he had a fall from staircase and sustained a traumatic brain injury (diffuse axonal injury as suggested by MRI reports) and colle's fracture of right side. Consequently, he was admitted to a nearby hospital. He was discharged after thirteen days with a nasogastric tube for feeding. He was at home in a state of coma for two months and was continuing physiotherapy there only.

He was examined by us after 2 years of his injury and reported that he is having difficulties with balancing and gait pattern and generalized weakness of muscles. As per the chief complaint the examination part went as follows. Sensory examination revealed Superficial, deep and combined cortical sensations to be normal. Motor examination showed tone equal to 1 on Modified Ashworth scale for right upper and lower limb. The deep tendon reflexes were elicited (knee and ankle jerk) with Babinski sign positive. Range of motion of all the joints were within normal limit. Muscle strength of right side upper extremity and lower extremity were $3^{+}/5$. And for left sides were 4/5.Trunk flexors was graded as 2/5 and extensors 3/5. Sitting (both static and dynamic) and standing (static) balance was fair. Most components of the non-equilibrium co-ordination tests were rated 3 on a 5-point arbitrary score. Sharpened Romberg's sign, Romberg's sign, and standing with feet together on equilibrium co-ordination tests were rated as 'severely difficult' on the 5-point arbitrary ordinal scale. Gait evaluation revealed step length to be more on left side with wide base of support, decreased arm swing, inadequate knee flexion and normal heel to toe pattern was absent. His baseline functional independence score was 90/126 and berg balance score was 27/56 which indicates that he is under medium fall risk.

Outcome variables: We implemented Berg balance scale (BBS), functional independence measure (FIM) and gait parameters using computer dynamography (CDG) as outcome variables for our study.

BBS: The Berg Balance Scale is a 14-item scale designed to measure balance in a clinical setting by assessing the performance of functional tasks. It is a valid instrument used for evaluation of the effectiveness of interventions and for quantitative descriptions of function in clinical practice and research. Its reliability is ICC=.97.

The Functional Independence Measure (FIM)

This scale assesses physical and cognitive disability. This scale focuses on the burden of care. Interrater reliability ranged from .89 to 1.00.

Computer dynamograph (CDG)

It has got eight channels EMG as attachment to measure angular deflection (used for gait analysis) L4 channel goniosensor are there. Components of CDG are utraflex micro controller with 2MB RAM, battery power (7.5-8.5 v) , sensor shoes (surface sensor for force distribution sensing), transducer for converting input signal into electrical signal, analogue to digital converter, pre amplifier (to amplify the signals), ultraflex 2.0 software.

Parameters for gait analysis are cyclogram, data values, force gaitline, force graphics, gaitline, histogram and step time

Intervention

Warm up: A 5-10 min. warm up session including stretching of major lower limb muscle group were designed for RA following which exercises for improving balance & muscle strength were performed by him.

Strengthening exercise: With patient in supine lying, primarily PNF techniques for upper and lower limb strengthening (D1 & D2 flexion & extension pattern) were applied (fig 1 & 2). For trunk flexors and oblique's abdominal curls , diagonal curls with patient in supine lying with both his hip and knee flexed to 90° was done and for trunk extensors, extension with patient in prone position was done.10 rep 2 sets for 3 times a week.

(FIG.1)

(FIG.2)

Fig. 1 and 2:- PNF pattern for upper and lower limb respectively.

***Balance exercise*:** For improvement of balance, functional exercises like weight shifting exercise, single limb loading (fig.3), tandem stance (fig.4) were done. Ball catching and throwing in diagonal direction with different speed and reaching activities in different direction were performed with patient sitting on a gym ball with both his foot supported on a ground and with patient standing on a floor ,were given (fig.5 & 6). It was done for 60 min. thrice a week.

Fig 3:- Weight shifting exercise, single limb loading.

Fig 4:- Tandem stance.

***Cool down*:** There was a 10-minute cool down where the participants performed gentle stretches, and then in a seated position practiced relaxation and controlled breathing.

Fig 5 and Fig 6:- Ball catching and throwing in diagonal direction with different speed and reaching activities in different direction were performed with patient sitting on a gym ball with both his foot supported on a ground and with patient standing on a floor.

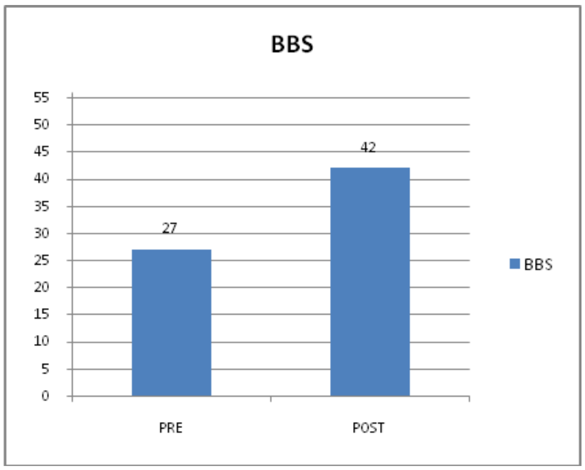

Fig.7 BBS score.

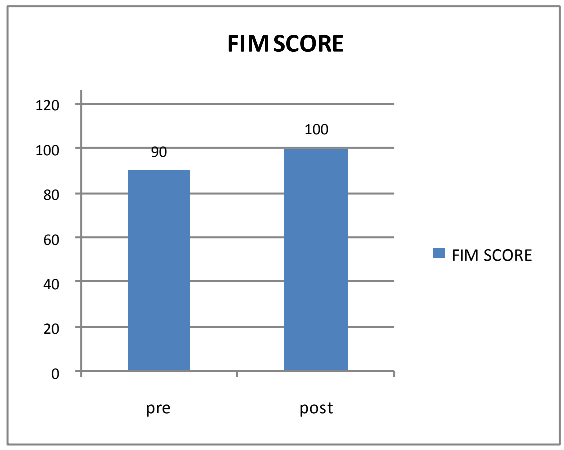

Fig.8 FIM score.

RESULT

On completion of the planned intervention for the child his balance improved thereby leading to improvement in functional independence. This is indicated by scores on the following scales.

Table1: Maximum, pre and post intervention values of Outcome measures:

Outcome measures	Maximum value	Pre- intervention	Post-intervention
BBS (fig.7)	56	27	42
FIM (fig. 8)	126	90	100
CDG			
cycle	1-1.30	1.51	1.37
frequency	100-126	79	88
Symm L/R	0.90-1.10	1.20	1.14

DISCUSSION

An increase in BBS, FIM score and hence gait parameters were noted after performing strengthening and balance exercise. However, the improvement of these parameters is far behind the normal values. The reason for improvement in the outcome measures may be due to the fact that, muscle weakness and impaired postural control in individuals leads to decreased weight bearing on the weaker lower limb resulting in abnormal stance stability (Pai et al., 1994; Mizrahi et al., 1989) Thus, asymmetric loading has been described as one of the sources contributing to disordered hemiparetic gait (Wall, 1986). Dickstein

(1984) and Sackley (1992) conducted a study on weight-bearing in persons following stroke and confirm that re-educating symmetrical stance is important in improving balance control. Thus weight shifting exercise is important for equal weight bearing. The ability to initiate and control voluntary weight shifts toward either leg is an important prerequisite for walking and it is therefore not surprising that weight-shifting training has an impact on asymmetrical gait pattern (Haart et al., 2005).

For the single-leg loading, balance performance improved, however, after strength training, presumably based on the training effect on the reflex control of muscle activity induced by exercising in the closed kinematic chain with known proprioceptive effects. The gain in strength may be explained by an improved intramuscular and intermuscular coordination, as well as by a more activation of agonists, thus achieving stabilization of the extremities (Rutherford, 1986).

The effect of resistance exercise on muscle strength and size has been clearly documented by Hakkinen et al., 1998 and Hortobagyi, 2000 suggested that resistance training in absence of balance training, also has a positive effect on balance. Lord et al., 1991found that strengthening exercises contribute to better balance and gait.

Balance exercises which we were given like ball catching and throwing and reaching activities are multidimensional exercises which focused on improving postural alignment in sitting and standing positions, developing coordinated movement strategies for recovery of balance in sitting and standing, improving the use of senses for postural orientation, improving the ability to make effective anticipatory postural adjustments prior to voluntary movements, and integrating appropriate sensory and motor strategies for controlling posture and balance into functionally related balance and mobility tasks (Cook et al., 1997).

Balance training, increases the sensitivity of feedback pathways and shortens the onset times of the selected muscles by improving the sensitivity of the position sense of both agonistic and antagonistic muscles (Kollmitzer et al., 2005). The muscle, being the termination point of the final pathway of the sensorimotor system, particularly contributes to the maintenance of body balance. It has been documented that resistance training that increased muscular strength also increased stability and coordination. (Carroll et al., 2001). Improvements in task performance were accompanied by changes in the pattern of recruitment of the muscles that were the focus of the resistance-training programme.

Overall improved trunk and lower extremity strength may have resulted in increased core stability and balance during gait, allowing increased comfort during walking and therefore increased speed. Many researchers concluded that treatment techniques such as strength training affected gross motor ability and may have had a carry-over effect on walking efficiency.

A possible explanation for the change in gait parameters after a strengthening program may be a result of increase in strength that may have helped to increase their stability and allowed the child to increase his/her step length. Another explanation is that the child had an improved sense of well-being resulting in improved confidence and quality of movement (Kramer, 1994)

The result of this study is limited due to the factors which include firstly the short duration of the study and secondly the years after the onset of the condition, since studies have proved that progression of improvement occur at a slow rate after 2-5 years of TBI.

CONCLUSION

By using above mentioned protocols, we got satisfactory results which are indicated through the improved scores in outcome measures & this proves that exercise regime which we have used in this case is effective in improving balance, muscle strength , gait pattern & functional independence & thereby the quality of life of TBI survivors.

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