Effectiveness of Trunk Balance Exercises along with Parallel Bar training in managing the balance disorders post Thoracic spinal surgery: A Case Report

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Abstract

Background

Due to the number of domestic and traffic injuries, there is an increase in the number of patients with traumatic injuries like muscle injuries, contusion and minor injuries, vertebral fractures etc. Vertebral compression fractures of the thoracolumbar spine are common in elderly. Approximately 25% of the post menopausal women are affected by the compression fracture during their life time. Various physiotherapeutic interventions required like mobility exercises, flexibility exercises strengthening exercises, balance activities, functional activities and most important ambulatory training.

Case Description

A 67 yrs old female retired physician presented the complaint of weakness at the lower back and both the legs. She has history of fall on the back and got T10 vertebral compression fracture. She is a known case of hypertension since approximately 10-12 years. The muscle power of bilateral lower limb depicted around grade 2+ and grade 3 that causes difficulty in weight bearing, standing and maintaining balance. This patient also presented signs of depression and fear of fall.

Outcomes

The post intervention readings shows the average improvement in all seven outcome measures. There was average increase in the Functional Reach Test (FRT) in all directions was about 30-35%. Similarly improvement was seen in Berg Balance Score as well as in Romberg’s test. The score in the Hamilton Depression Rating Scale (HRDS) also found to be improved.

Conclusion

This case study described the effect of trunk balance exercise along with the parallel bar training in the post spinal surgery patient. Conventional Physical therapy has a demonstrating promising effects in post vertebral compression fractures. This case has showed overall overall success, as the condition of the patient was improved after the treatment.

Key works

Introduction

The axial skeletal (spine) is considered as a complex structure which consists of bones(vertebrae), intervertebral discs, muscles, ligaments, nerves which allows both mobility and stability of the back. It has been considered as an strongest pillar of the body on which the cranium and caudal ends of the body exists. Numerous low back problems can be prevented if there is maintenance of an acceptable body weight, correction of postural symmetry, maintenance of good abdominal tone, core and lower limb stability.

Due to the number of domestic and traffic injuries, there is an increase in the number of patients with traumatic injuries like muscle injuries, contusion and minor injuries, vertebral fractures etc. In the elderly, the risk of traumatic fractures is rising due to an increased risk of falls due to may be cardiac or cerebrovascular diseases. Another reason might be the altered bone metabolism which leads to increase the bone fragility and fracture tendency.

Vertebral compression fractures occur at the thoracolumbar spine commonly appears in elderly. The prevalence related to this condition increases with age. Approximately 25% of the post menopausal women get affected by the compression fracture during their life time. Post menopausal women have a greater risk of fractures due to the hormonal changes which leads to osteoporotic bone. Bone mineral density reduction disrupts the micro architecture of bone which in turn alters the contents of non collagenous protein in the matrix. Thus the tissue structural deterioration leads to fragility of the bone and get more prone to fractures.

These type of fractures holds the potential to cause some significant disability, which often cause incapacitating back related issues like pain or stiffness for many period of time. Studies have suggested having one vertebral fracture increases the risk of future vertebral compression fractures. Existing fractures leads to segmental instability when the collapse of vertebral body exhibits more than 50% of initial body height. This increase the strain on the adjacent soft tissue structures which may results in degeneration of spine.

Risk factors for these kind of fractures includes impaired eyesight, tobacco use, alcohol consumption, osteoporosis, estrogen deficiency, early menopause, low body weight, vitamin D deficiency, insufficient physical activity, dietary calcium deficiency, dementia, susceptibility to falling. In addition to this, obesity also may leads to increase the quantities of sex hormones, especially estrogen, that promotes osteoblast activity.

As these many factors are involved in the fractures or injuries of spinal vertebrae, patients are more likely to undergo for the invasive spine surgery procedures. The most common surgical procedures are vertebroplasty/kyphoplasty and spinal fusion. Patient has to undergo with required metallic implants like metal screws, rods cages which used to stabilize the spine. Apart from these surgical interventions, patients are required to be immobilized for a required period of time. This leads to weakness of the muscles, nerve, bones of spine as well as lower limb. In this condition, physiotherapeutic intervention plays a great role post surgery.

Various physiotherapeutic interventions required like mobility exercises, flexibility exercises strengthening exercises, balance activities, functional activities and most important ambulatory training. So the purpose this study carries is to validate the effect of trunk balance exercises incorporation with the ambulatory training to the patient who underwent through the thoracic spinal surgery. In this study, the tailored made protocol has been implemented on the post surgical patient which has depicting promising result in improving the strength, balance and ambulation along with the quality of life.
2. Case Study

A 67 yrs old female retired physician presented the complaint of weakness at the lower back and both the legs. She also presented with the balance difficulty as she couldn’t able to stand independently from the wheelchair since one year. While interviewing her, she revealed the history of fall in the bathroom as she slipped on the floor while taking bath one year back. She reported as she hitted her back on the floor but was conscious during that episode. She was immediately taken to the hospital where she was suspected with the compression fracture of the T10 vertebral body in the radiological investigations. The fracture was considered as stable and was not displaced which is why she didn’t show the neurological symptoms. Instrumentation was accompanied by the fusion to maintain the spine in the corrected position in surgery. She is a known case of hypertension since approximately 10-12 years. She also reported the known case of depression since childhood. No history of any other medical issue, diabetic issue, infection, gynaecological issues, cardiovascular or neurological problems was reported. On observation, the built of the patient was ectomorphic. There was no unusual swelling, redness at the incisional area at back of the patient. The muscle wasting of the hamstrings, quadriceps, dorsi and plantar flexors was observed. She also reported the pain sensation on the bilateral knee joints from past 2 months episodically. No visible deformity was noticed. While palpating the lower limb muscles, the tone was soft and skin texture was normal. There was grade one tenderness present on the distal quadriceps. The nature of the pain was evaluated as aching which noticed to get aggravated after some of the physical activity. The sensory examination revealed no deficits in the lumbosacral area as well as lower limbs. On motor examination, the muscle girth of the lower limb muscles was reduced. The tone of lower limb muscles was assessed by passive and active movements. On examination, active assisted ROM of bilateral hip, knee and ankle joint was measured complete and normal. The power of the lower limb muscles, showed the reduced muscle strength. The manual muscle testing outcome measure was used to evaluate the power which showed grade 2+ of quadriceps, hamstrings and plantar flexors on the left lower limb. While assessing on the right side, it was measured as a grade 3- of the hip flexors, knee extensors, grade 3+ of plantar flexors. The hip extensors bilateral were measured grade 2+ strength, knee flexors was grade 3+ bilaterally in the prone lying position. The lumbar extensors, obliques, abdominals were examined and measured grade 2+ strength. The postural control and balance was evaluated using Functional Reach Test(FRT) in multiple directions and Berg Balance Scale (BBS). The patient depicted the score of 16cm in forward reach. The patient scored 35 on BBS. Romberg’s test for balance was also used to assess the balance of the patient in eyes open and eyes closed. The patient was able to maintained the balance without support for 8 seconds with the eyes open so further levels of assessment was not proceeded. For gait speed and risk of fall, Timed up and Go test along with the 10m walk test was used. She scored 10seconds on TUG and 0.18m/s for 10MW test. The Functional Independence Measure(FIM) scale was used as a tool to explore the physical, psychological and social function. The patient depicted 2 level of FIM score on assessment. Some of the findings were related to the fear of fall and mild depressive status. According Hamilton Depression Rating Scale (HDRS), patient scored 25 which is higher and skewed towards moderate to severe depression.

3. Research Methodology

A 67 year old female diagnosed with the post thoracic spinal surgical lower lumbar weakness as well as balance disorder has been selected for this case study. The study was approved by Institutional Ethical Committee and written consent was signed by the patient. A physiotherapy protocol of 4 weeks has been given to the patient. The baseline assessment was done on the 2nd day of the arrival of patient in Physiotherapy Out Patient Department (OPD), under the Department of Physiotherapy, Lovely Professional
University. Post intervention readings were recorded after 4 weeks of baseline assessment. The total 6 outcome measures has been used to assess the progress of strength, balance and gait in the patient.

3.1 Outcome Measures

3.1.1 Manual Muscle Testing (Daniel and Worthingham’s Scale)

The test of muscle strength use to be perform as a part of patient's objective assessment and considered as an important tool for the physical examination. This scale has been found effective in differentiating the weakness from imbalance or poor endurance. This method involves the testing of the key muscles from the upper, lower and back muscles which is performed against the resistance offered by therapist and anti gravity also.

3.1.2 Functional Reach Test (FRT)

The procedure has been executed in multiple directions forward, backward and sideways. A measuring tape was wall mounted parallel to the floor. The patient was instructed to stand bare feet and comfortable distance apart, making a fist and flexing the arm at 90 degrees against wall. The reading was marked on the measuring tape where the MCP joints of the fist lined up. After attaining this position, the patient was instructed to reach in front maximally according to his capability without taking a step in forward direction. Similar instructions were given for backward and sideways.

3.1.3 Berg Balance Scale (BBS)

This is a widely used clinical test which used to measure the static and dynamic balance abilities. Thus it also considered as an objective and gold standard scale used to evaluate balance abilities. There are 14 items in this scale. These items tests the patient’s ability to maintain positions or movements in different scenarios ranging from minimal to maximal difficulty. The base of support is reduced in progressive items such as sitting and standing to single leg stance. It also assesses the patient’s ability to change positions.

3.1.4 Romberg’s Test

The Romberg’s test which is commonly used method of quantifying balance .This test required no equipment to be performed which makes it very suitable for large scale deployment. The subject is asked to stand with his two feet together. The patient gets the instructions to stand with eyes open initially, and afterwards with eyes closed without any physical disturbance. Ask patient trying maintaining the balance. As for the safety purpose, it is important that the therapist must stand near to the patient to prevent any falling injury. The Romberg test would be scored with the count of some seconds while maintain the balance with eyes closed.

3.1.5 Timed Up and Go Test

This tests assesses walking, dynamic balance along with the risk of falls in patients. For this chair with arm rests, stop watch and measuring tape is required. The patient was instructed to be in a seated position at the beginning of the test. The therapist commands the patient to stand and start walking for 3 meters then turns around and continue walking back to chair and sits down. The time duration is noted with the help of stop watch. The time stops when the patient was seated. The average of three trials has been considered for assessment.
3.1.6 10 minute walk test

It is the performance based test used to evaluate gait speed to determine functional mobility. The patients are asked to walk without any assistance for 10 meters, with the time recorded for intermediate 6 meters to allow progression of gait speed and deceleration. The time needs to be noted when the toes pass the 8 meter mark. The patient was made to walk at his preferred walking speed and maximum walking speed both. The average of three trials has been considered for assessment.

3.1.7 Functional Independence Measure scale

The FIM scale is used for the assessment of the levels of the functional status of a person based on the level of assistance patient required. This scale has some grading categories which range from “total dependence with assistance” to “complete independence without assistance”. Tasks which are evaluated using this scale includes bowel and bladder control, locomotion, transfer, social cognition, communication and six self care activities like feeding, grooming, bathing, upper body dressing, lower body dressing.

3.1.8 Hamilton Depression Rating Scale (HDRS)

The HDRS is the clinician-administered depression assessment scale which is widely used. In the scoring method, score between 0–7, does accepted to be within the normal range or in clinical remission, and score at 20 or higher indicates least moderate severity.

Physiotherapy Treatment Protocol

The physiotherapy intervention for this case used strength training, trunk balance exercises and parallel bar walk training. It was given for 40-45 minutes*6 days for 4 weeks. Prior to the intervention started, some of the trunk, hip, knee and ankle mobility exercises were introduced.

Mobility exercises: Pelvic rotations, hip and knee movements, hip rotations, ankle dorsiflexions, ankle toe pumps and ankle rotations. These mobility exercise protocol was depicted as a warm up session to the patient.

Dosage for these mobility exercises was 10 repetitions for 5 sets which was increased at 3rd week of the protocol upto 20 repetitions for 5 sets. For first and second week, passive and active assistance was required. In third and fourth week, active mobility exercises were being done by the patient itself.

Strength Training: Abdominal curls with support: 5 reps*3 sets initially. These were progressed upto 10 reps*3 sets.

- Mckenzie’s back extension exercises with forearm support and in elbow extension. Dosage: 20 secs hold and 5 secs rest *3 sets.
- Pelvic bridging exercises. Dosage: 20 secs hold and 5 secs rest* 10 sets
- Straight leg raise exercises alternatively : 20 repetitions *3 sets
- Knee isometrics : 20 secs hold* 5 secs rest * 3 sets
- Static cycling :5-7 minutes during initial sessions. 10 minutes afterwards.
- Straight leg abduction exercises alternatively : 20 repetitions *3 sets.
- Prone gluteal squeezes : with arm raise, leg raises, alternate arm and leg raise. Dosage : 20 secs hold* 5 secs rest * 3 sets
- Quadruped : with alternating arm and legs.
- Kneeling stabilization : double knee, single knee. Dosage: 20 secs hold* 5 secs rest * 3 sets
- Dynamic Quadriceps exercise. Dosage:20 repetitions*2 sets alternatively.
Trunk Balance exercises:

1. Trunk, Head and upper limb rotation from kneeling
   - Patient position: Kneel on a pillow with arms abducted to 90 degrees.
   - Instructions: Ask the patient to rotate the head, trunk and arms to one direction.
   - Dosage: Maintain the position for atleast 30 seconds in each direction, and repeat it for 2 times per direction.
   - Progression: Make it more challenged by one eye closure and then head extension.

2. Upper limbs flexion and extension on kneeling
   - Patient position: Kneeling position on a pillow.
   - Instructions: Instruct to look towards the ceiling while moving arms above the shoulder.
   - Dosage: Maintain it for 3 minutes, perform 6 repetitions.
   - Progression: Make it more challenged with adding eye closure.

3. Pelvic bridging with one sided straight leg raise
   - Patient position: Supine with feet resting on the couch.
   - Instructions: Lift the pelvis up, after reaching maximum hip extension and raise one lower limb from the couch and extend the knee.
   - Dosage: Maintain it for 30 seconds, and repeat twice for each lower extremity.
   - Progression: Make it more challenged by one eye closure and ball under the legs or foot on the couch.

4. Core Swiss Ball Exercises
   - Back Extension:
     1. Make the patient to first kneel on the mat.
     2. Instruct the patient to slowly lean on the swiss bass over his back while maintain the pelvis and bringing the back parallel to the mat.
     3. Instruct the patient to cross the arms over chest.
     4. The move:
        1. Guide the patient to hold the upper body contracted as a unit.
        2. Instruct the patient to move the ball back and forth with the feet, legs pushing the mat and squeezing the lower back muscles, gluteals, thigh and leg muscles.

5. Knee Extension while sitting on swiss ball.
   - Strap ankle weights on both ankle.
     1. Make the patient to sit on swiss ball. Keep the legs slightly separated as knees and feet are hip-width apart.
     2. Keep the knees in 90 degrees while sitting on the ball.
     3. Keep the hands on the quadriceps or let hands swing at the sides of the body.
     4. The move:
1. The patient has to exhale while lifting one leg slowly and in a controlled manner while maintaining the leg straight.
2. Hold the lifted position and count 1 second.
3. Inhale slowly while lowering down the leg to the starting position.
4. Repeat the same move with another leg.

6. Parallel Bar Training:
   - Make the patient to stand on the parallel bar with the feedback mirror in front.
   - Active leg swinging exercises were initiated in alternative method for 5 minutes duration.
   - Then patient started walking on the parallel with minimal assistance and it was repeated for 5 times per session.
   - On the second round on parallel bar, patient was asked to raise the heels with bars support for about 10-15 times for 2 sets with 20-30 seconds rest in between.
   - Standing marching was also introduced in this training for 5 minutes with the break of 1 min.

4 Results
The intervention has shown improvement in all seven outcome measures. The muscle strength was improved at grade 4 after the four week sessions of treatment. The average increase in the Functional Reach Test (FRT) in all directions was about 30-35%. Similarly improvement was seen in Berg Balance Score which was 35 at the baseline and 50 post intervention. Patient was able to hold the balance for more than 20 seconds in Romberg’s test post intervention which was 8 seconds measured pre intervention. Improvement was noted in 10m walk test from 0.18m/s to 15 seconds. The score of TUG test was improved from 10 seconds to 7 seconds. The FIM score was also improved from level 2 to level 4. The post training assessment has shown improvement in all parameters. The HDRS score found to be 12 post intervention.

5 Discussion
Conventional physiotherapy intervention has shown maximum good results in treating the muscle weakness, balance and locomotor abnormalities. This case study included the simple strategies for improving the strength of the lower back as well as lower limb muscles. This study also incorporates the effectiveness of the balance training in balance difficulty which induced due to less power in the muscles. That ultimately leads to the ambulation difficulties. The leading study also shows the effective results of gait training in the parallel bar along with some exercises. The type of exercises chosen in this study focus on overall involvement of body systems which may be musculoskeletal system, visual system, auditory system, neurological system, vestibular system and proprioception. For improving the balance, neuromuscular input of the body is required which in turns control the center of mass (COM) and limits of stability(LOS). Due to less muscle power and balance, the COM and stability factors gets altered in the patients. The findings of Alexandru.D, William.S also gives the idea about the risk of compression fractures of vertebrae which are more prone in post menopausal women. These fractures often cause incapacitating back pain and morbidity. The most important step to prevent fractures is to treat the osteoporosis. Trunk balance exercises along with the strength training plays the role in reducing pain and decreasing disabilities. Regarding the balance training while using the stability or
swiss ball, it offers a fun and helps to improve strength, flexibility, balance, endurance and core stability. Swiss balls are less stable that puts more challenge and engages the whole core muscle while performing the strengthening exercises. The balance training is very effective in the improvement of proactive and reactive balance strategies as well as for the performance. Research also shows that the conjunction of lumbopelvic training programme including posterior pelvic tilts with the lower extremity movement increases lumbopelvic stability and blood flow to the post surgical patients. The patient in this study showed the muscle atrophy pre intervention. Researches also speculates that patients who are regular with the exercises found less affected by disuse atrophy during initial phases after spinal fracture. Regular exercises should be encouraged to prevent the reduction in the activities of daily life after vertebral fracture mainly in the elderly patients. This also incorporates to improve the functional independence and quality of life. As this study also hints about the depression case of the patient which usually occurs post menopausal and elderly women. Due to some mental disturbance, the chances of the getting low, unfocused, disoriented gets increased. Some studies also suggests that the depression can leads to disability and affects the interpersonal relations and social functions which might costs high amount to health care system. Some of the comprehensive intervention programs can be developed for decreasing the depression in post menopausal women considering all these influencing variables. In this study, patient presented the temporary loss of mobility and execution of certain things. Communication with the patient by the therapist allows to develops the emotional support to develop realistic expectations. The psychological support was provided to the patient during the physical therapy sessions which showed positive and good effects resulted out to be more enthusiastic physical exercise output.

6 Conclusion
This case study described the effect of trunk balance exercise along with the parallel bar training in the post spinal surgery patient. Conventional Physical therapy has a demonstrating promising effects in post vertebral compression fractures. This case has showed overall overall success, as the condition of the patient was improved after the treatment.

7 Limitations
It has been found the main limitation of this study regarding the psychotherapy. Some specialized psychologists would have been involved in this study for the counselling and emotional supportive therapy. Cognitive Behavioral Therapy (CBT) would also have been added in this study.

8 Future Scope of this study
This should be combined study including Physical Therapist and Psychologist. Some more advanced techniques can be introduced to intervene the balance training and parallel bar training.
References