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Assorted ways for gait rehabilitation for a patient with amyotrophic lateral sclerosis

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ABSTRACT

Amyotrophic lateral sclerosis (ALS) is a progressive neurodegenerative disease and the commonest type of motor neuron disease (MND). It demonstrates symptoms of both the upper motor neuron (UMN) lesion and the lower motor neuron (LMN) lesion. In this case report, we present a case of a patient with ALS who had slight increased muscle tone, weakness in bilateral lower extremity muscles, and most predominantly a disturbed gait pattern. The patient's expectations from physiotherapy were to gain back a near-normal gait pattern, hence, an appropriate management protocol was made for him while using conventional treatment such as strengthening, PNF, rood's technique etc. as well as advanced techniques such as functional electrical stimulation (FES) with treadmill training, aquatic gait training and vestibular sensory training to attain the patient and therapist's goals. Outcome measures used were Berg balance scale, dynamic gait index and functional independence measure at the beginning and end of the 7 weeks of rehabilitation. To conclude, we are positive that both conventional and advanced physiotherapy techniques have contributed in improving the gait pattern and parameters of a patient suffering from ALS.

Keywords: Motor Neuron Disease, Amyotrophic Lateral Sclerosis, Physiotherapy Rehabilitation, Gait Training, PNF, Rood's approach

1. INTRODUCTION

MNDs are the result of malfunctioning of UMNs in the frontal lobes precentral gyrus or LMNs in the spinal cord's ventral horn. They generally present no noticeable distress or sensory signs but weakness. ALS is the most prevalent MND, with a frequency of roughly 2 in 100,000 people (Foster and Salajegheh, 2019). It is a progressive neurodegenerative condition that predominantly affects the human motor system, although extra-motor symptoms are being recognized more now. The increasing weakness and wasting of muscles are caused by the loss of LMN and UMN in the anterior horn of the spinal cord, the motor cortex and the brain stem nuclei. This disease usually has a localised onset but extends throughout the body areas, with loss of respiratory muscles limiting lifespan to 2–5 years following illness onset.

Progressive muscular weakness, fasciculations, muscle atrophy, muscle spasms, and muscle stiffness with the slowness of movement are the hallmark of ALS. Extra-motor symptoms such as behavioural abnormalities, language impairments and executive dysfunction occur in up to 50% of patients. ALS has not found any cure or effective treatment to this day; hence, multidisciplinary care remains the cornerstone of treatment (Masrori and Van Damme, 2020). Motor and respiratory therapy improves patients' quality of life and allows them to function for longer periods, especially when physiotherapists persuade patients and family members to do the prescribed exercises at home as well (Pozza et al., 2006). In this case report, the focus of the physiotherapy management will be on training the gait of the patient to bring it back to near-normal and improvement of other problems related to his condition such as increased tone, lower limb weakness etc.

2. PATIENT INFORMATION

A 52-year-old male electrical worker came to the physiotherapy department with pre-diagnosed amyotrophic lateral sclerosis. The onset of symptoms was dictated 2 years back by the patient who began with weakness in bilateral lower limbs then difficulty in balancing while walking then difficulty in lifting his feet and difficulty in wearing slippers, all these complaints were progressive. He also had a complaint of minimal forgetfulness such as difficulty remembering the direction. He had a positive history of hypothyroidism but other comorbidities such as diabetes mellitus, hypertension and any other familial history of similar complaints as above were absent.

3. CLINICAL FINDINGS

On observation, the most striking finding was the patient's gait, which had staggering, lack of heel strike, buckling of the knee, flattening of the arches of the foot, reduced step length; stride length, velocity and cadence. On examination, there was asymmetrical muscle weakness; extreme weakness was found in the right peroneus longus, peroneus brevis, and quadriceps muscles. Sensations were intact and normal but the muscle tone and reflexes were increased slightly. There was affection of dynamic balance with presence of mild dysarthria and dementia. According to the El Escorial criteria, he was a case of definite ALS.

Investigation findings

Electromyography was performed on the patient's lower limb musculature, which revealed fasciculation and spontaneous denervation discharges which are positive sharp waves and fibrillation potentials in relaxed muscle; and chronic neurogenic alterations were seen upon contraction.

Therapeutic Intervention

The patient had been taking multivitamins and thyroid supplements since his diagnosis. For the complaints of dysarthria, he was referred to a speech therapist and the rest of his treatment was carried out in the physiotherapy department. His physiotherapy intervention was formed for 7 weeks which included basic strengthening for the weakness in the lower limbs, reduction of the tone through Rood's approach, dynamic balance training etc. but the major focus of the therapy was given to the gait of the patient for which various approaches were utilised including, proprioceptive neuromuscular facilitation (PNF) for trunk and pelvic musculature activation (Figure 1 and 2), functional electrical stimulation (FES) with treadmill training (Figure 3), aquatic gait training, vestibular sensory training (Figure 4) and so on. The summary of all the interventions along with the goals of 7-week program is given in Table 1. After his rehab program, he was given a home exercise program and a follow-up date every month to keep a check on his condition and/or to modify the home exercise program to patient's comfort and requirement.

Table 1 Summary of the physiotherapeutic goals and intervention for 7 weeks

Summary of the first week of rehabilitation			
Sr. no.	Goals	Intervention	Regimen
1.	To educate the patient regarding his condition & what to expect from physiotherapy	Patient counselling	Before beginning the session and whenever required later on
2.	To reduce the tone in the muscles	Rood's approach, using sustained stretching and tendinous pressure	Twice daily for 10 minutes for 6 days a week

3.	To increase the strength in the lower limb muscles	Active resisted exercises using 0.5 kilograms of weight for major muscles of the lower limb (Gluteus maximus, medius and minimus; quadriceps; hamstrings; gastro-soleus; plantar and dorsiflexors; evertors)	3 sets of 15 repetitions of each exercise, thrice a week
		Aerobic exercises including static cycling	15 minutes, thrice a week
4.	To activate pelvic musculature for appropriate gait training	Slow reversals PNF technique for pelvis in side-lying (Figure 1)	3 sets of 10 repetitions once daily for 6 days a week
5.	To activate the trunk musculature for appropriate gait pattern	Trunk PNF patterns while giving target-oriented reach outs (Figure 2)	3 sets of 10 repetitions once daily for 6 days a week
6.	To improve the dynamic balance of the patient	Perturbations in sitting and standing	5 minutes of each activity training, 6 days a week
		Wobble board training	5 minutes, 6 days a week
7.	To improve the gait pattern	FES over bilateral legs	15 minutes of stimulation for 6 days of the week
		Aquatic gait training	10 minutes of walking and 10 minutes of jogging underwater, thrice a week
Summary of the second week of rehabilitation while continuing the interventions of the first week except for the progression and addition of those mentioned bellow			
1.	To further increase the strength in the lower limb muscles	Active resisted exercises using 1 kilogram of weight for major muscles of the lower limb (Gluteus maximus, medius and minimus; quadriceps; hamstrings; gastro-soleus; plantar and dorsiflexors; evertors)	3 sets of 15 repetitions of each exercise, thrice a week
2.	Gait training	Ambulation with FES on a treadmill with mirror feedback (normal base of support walking; forward, backward, sideward and tandem walking) (Figure 3)	4 sets of 5 minutes training of for each component, twice daily for 6 days a week
		Aquatic gait training	15 minutes of walking and 15 minutes of jogging underwater, thrice a week
		Vestibular sensory gait training (Figure 4)	3 sets of 5 minutes of training, 6 days a week
Summary of the third and fourth week of rehabilitation while continuing the interventions of the first and second week except for the progression and addition of those mentioned bellow			
1.	To further increase the strength in the lower limb muscles	Active resisted exercises using 1.5 kilograms of weight for major muscles of the lower limb (Gluteus maximus, medius and minimus; quadriceps; hamstrings; gastro-soleus; plantar and dorsiflexors; evertors)	3 sets of 15 repetitions of each exercise, thrice a week
2.	Gait training	Ambulation without FES on the	3 sets of 5 minutes of

		treadmill with mirror feedback	training, 6 days a week
		Vestibular sensory gait training	3 sets of 10 minutes of training, 6 days a week
Summary of the fifth and sixth week of rehabilitation while continuing the interventions given above except for the progression and addition of those mentioned bellow			
1.	To further increase the strength in the lower limb muscles	Active resisted exercises using 2 kilograms of weight for major muscles of the lower limb (Gluteus maximus, medius and minimus; quadriceps; hamstrings; gastro-soleus; plantar and dorsiflexors; evertors)	3 sets of 15 repetitions of each exercise, thrice a week
2.	Gait training	Independent ambulation with mirror feedback	3 sets of 10 minutes of training, twice a day for 6 days of the fifth week
		Obstacle walking with assistance	3 sets of 10 minutes of training, twice a day for 6 days of the sixth week
		Stair climbing with mirror feedback	3 sets of 10 minutes of training, twice a day for 6 days of the sixth week
Summary of the seventh week of rehabilitation while continuing the interventions given above except for the progression of those mentioned bellow			
1.	Gait training	Independent obstacle walking	3 sets of 10 minutes of training, twice a day for 6 days of the seventh week
		Stair climbing without mirror feedback	3 sets of 10 minutes of training, twice a day for 6 days of the seventh week
2.	Home exercise program	Strength training, sustained stretching and endurance training	3 days strength training, 3 days endurance training and all 6 days Rood's approach; for 6 days every week hereafter.
PNF: Proprioceptive neuromuscular facilitation; FES: Functional electrical stimulation			

Figure 1 Slow reversals PNF technique is being performed for pelvic musculature activation

Figure 2 Target-oriented activities being performed in PNF diagonal patterns

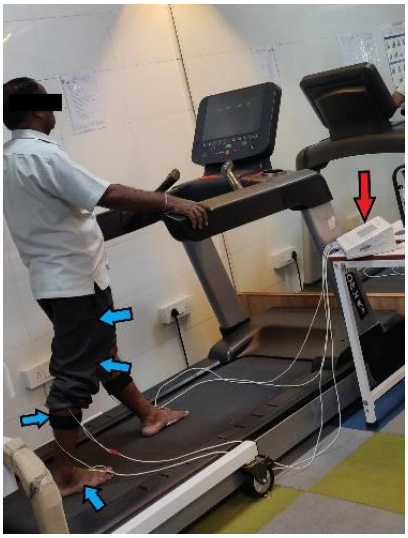

Figure 3 Patient is seen walking on a treadmill along with functional electrical stimulation and mirror feedback (Red arrow shows the functional electrical stimulator machine and blue arrow shows electrode placement)

Figure 4 Patient is seen performing ambulation on proprioceptive pads for vestibular sensory training

Outcome and follow-up

Outcome measures used to analyse the improvement in balance and gait parameters were the Berg balance scale, dynamic gait index and functional independence measure (Table 2).

Table 2 Outcome measures used to analyse the treatment result

Sr. no.	Outcome measure	Pre-rehabilitation	Post 7 weeks of rehabilitation
1.	Berg balance scale	37 (Medium fall risk)	44 (Low fall risk)
2.	Dynamic gait index score	18 (Predictive of fall)	27 (Safe ambulator)
3.	Functional independence measure	4 (Minimal assist)	5 (Supervision)

4. DISCUSSION

A patient, who was a victim of ALS, came to our department with a severely disturbed gait pattern. He was thoroughly assessed and a treatment protocol was made for him in whom we have utilized conventional physiotherapy along with some advanced techniques to train the gait and other problems such as increased tone, weakness in lower extremity muscles etc. from maximum aspects. In our conventional methods of treatment, we included muscle strengthening because of the weakness in lower limbs and also because it has been proven to show improvement in quality of life with early intervention for four out of six ALS patients in a study program (Gómez Fernández and Calzada Sierra, 2001).

According to a comprehensive study, exercise can dramatically enhance functional ability and lung function in people with ALS while having no negative effects. Patients with ALS who participated in a moderate-intensity exercise program focused on isometric strengthening and endurance/aerobic training saw enhancements in muscular strength, O_2 consumption and fatigue. Exercise has been shown to halt motor neuron degeneration, decrease stress on muscle fibber's that are fast-twitch in nature, reduce spasticity, strengthen muscles, increase musculoskeletal endurance, reduce fatigue, and improve cardiopulmonary function (Meng et al., 2020), hence, aerobics like static cycling was included in the management protocol.

Training in vestibular sensory stimulation has shown to be effective in improving gait and static-dynamic balance in patients with stroke (Jeong and Choi, 2014) hence, we gave it a safe try in our ALS patient. Gait ability has been shown to improve in patients with spinal cord injury who have used FES along with an electromechanical gait trainer which is a rehabilitation variant of a treadmill (Hesse et al., 2004) and since our patient was not at a complete loss of limbs we opted for a simple treadmill. At the end of 7 weeks of treatment, we found improvement in stride length by 100cm, step length by 12cm, cadence by 19 more steps than the pre-intervention readings and also improvements in other outcome measures (Table 2).

5. CONCLUSION

A 7-week physiotherapy intervention in the form of conventional as well as advanced techniques such as FES stimulation with treadmill training, aquatic gait training and vestibular sensory gait training has resulted in significant improvement in the gait pattern of a patient suffering from amyotrophic lateral sclerosis.

Acknowledgment

We thank the patient who co-operated with us during his treatment and consented to publish his case study for future references and our teachers to motivate us to do so.

Authors' contributions

RT suggested the idea of the publication of case report, TML constructed and formulated the manuscript, RT, SSHS, and SSL improved and approved the manuscript for further processing.

Informed consent

Written & oral informed consent was obtained from the patient.

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Conflicts of interest

The authors declare that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

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