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Original Research Article

A COMPARATIVE STUDY ON THE EFFECTS OF PELVIC PNF EXERCISES AND HIP EXTENSOR STRENGTHENING EXERCISES ON GAIT PARAMETERS OF CHRONIC HEMIPLEGIC PATIENTS

Hayy Y Patni *.

Consultant Physiotherapist, Mumbai, Maharashtra, India.

ABSTRACT

Background: Most hemiplegic patients who suffer from stroke experience restrictions on mobility at home and in the community, and they especially have difficulty with independent walking. Proprioceptive Neuromuscular Facilitation (PNF) is one approach commonly used to improve the gait of patients with hemiplegia. Various PNF procedures have been used, depending on the affected site. Among these PNF techniques is facilitation of pelvic motion to improve control of the pelvis.Hence the study was done to compare the effects of pelvic PNF exercises and Hip extensor strengthening exercises on gait parameters of chronic hemiplegic patients.

Materials and Methods: 30 subjects were conveniently divided into either of the two groups namely Pelvic PNF Group (Group A) and Hip extensor strengthening Group (Group B). Subjects in Group A received a protocol of 3 PNF techniques for 3 days a week for a total duration of 4 weeks (12 sessions). These procedures were done to facilitate anterior elevation and posterior depression of pelvis in a side lying position. Subjects in Group B received a protocol for hip extensor strengthening exercise (HESE) program. Each session consisted of 3 sets of 15 performances of the 3-step program lasting about 30 min, with 30 seconds of relaxation time between the sets. The measurements of the variables i.e. Gait speed, Cadence, Stride Length, Step Length was taken twice, one at the beginning of the study (Pre) and one at the conclusion of the 4 week duration (Post).The pre post measurements of outcome measures were analysed.

Results: Following 4 weeks of Pelvic PNF exercises and Hip extensor strengthening exercises, there was a statistically significant increase in Gait parameters in all domains. However the increase was statistically more significant in the experimental group (Pelvic PNF) as compared to the control group (HESE).

Conclusion: Pelvic Proprioceptive Neuromuscular Facilitation technique is more effective than Hip extensor strengthening exercises in improving gait parameters such as stride length, gait velocity and cadence in chronic hemiplegic patients.

KEY WORDS: Pelvic PNF, Hip Extensor Strengthening Exercises, Hemiplegia, Gait Parameters.

Address for correspondence: Dr. Hayy Y Patni, 5/85, Artist Village, Sector 8, Cbd Belapur, Navi Mumbai, Mumbai, Maharashtra, India. **E-Mail:** hayy.patni@gmail.com

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BACKGROUND

Stroke is the third leading cause of death and a major cause of disability. It is considered as a significant health problem, which needs an unremitting and wide-ranging rehabilitation [1]. Stroke is also known as “cerebral vascular accident”, “brain attack” or “apoplexy” [2,3].

According to WHO stroke is defined as “acute onset of neurological dysfunction due to abnormality in cerebral circulation with resultant signs and symptoms that corresponds to involvement of focal area of brain lasting more than 24 hours” [4]. Approximately 700,000 individuals in United States are affected by it each year.

About 500,000 are new strokes and 200,000 are recurrent strokes [5]. According to W.H.O (16 November 2011) the incidence of stroke in India was 130/100,000 individuals every year.

The estimated age-adjusted prevalence rate for stroke ranges between 84/100,000 and 262/100,000 in rural and between 334/100,000 and 424/100,000 in urban areas. In India, nearly one-fifth of patients with first-ever stroke admitted to hospitals has been estimated to be aged 40 years or more. And the mean age was 54.5 years. It has been estimated that hypertension causes 54% of stroke in low-income and middle-income countries, followed by hypercholesterolemia (15%) and tobacco smoking (12%) [6]. The Indian Council of Medical Research estimates that among the non-communicable disease, stroke contributes for 41% of deaths and 72% of disability adjusted life years [7,8].

Most hemiplegic patients who suffer from stroke experience restrictions on mobility at home and in the community, and they especially have difficulty with independent walking [9]. The recovery of gait ability is an important goal of physical therapy for a stroke patient, because gait is an important element of functional independence [10]. With regard to this, the biggest loss after stroke is gait ability, and hemiplegic patients show disorders in the selective ability of regulated and coordinated movements, which results in a slow gait velocity and compensatory movements by the lower extremity of the unaffected side [11]. It is suggested that hemiplegic patients show a short stride length and slow gait velocity that result in damage to the joint and to the regulatory function of the muscles that are necessary for normal gait [12]. Due to central nervous system damage, stroke patients show muscle weakness, abnormal muscle tone, and disorders of balance and posture control, which result in difficulty in the control of movement [13]. For these reasons, problems occur with the quality and adaptation of the gait pattern, resulting from imbalance in the low extremity stance phase of the affected side and of the low extremity stance phase of the unaffected side, a decline in cadence and gait velocity, asymmetrical weight distribution, and a difference between step length and stride length [14,15].

Proprioceptive Neuromuscular Facilitation (PNF) is one approach commonly used to improve the gait of patients with hemiplegia. Various PNF procedures have been used, depending on the affected site. Among these PNF techniques is facilitation of pelvic motion to improve control of the pelvis. Because the pelvis has been described as a “key point of control” for maintaining a gait pattern, techniques designed to affect the pelvis are widely used [16-19]. In persons with hemiplegia, posture, tone and coordinate reciprocal movements, which are required for normal gait, are usually impaired. Normal reciprocal pelvic movement is often replaced by a fixed pelvic retraction, which makes it difficult for patients to swing the affected lower extremity forward [19]. Co-ordination between moving body parts is essential for functional walking and is modified, often in a subtle manner, to accommodate variation in task requirements and circumstances, such as walking speed, path curvature, and environmental clutter [21,22]. The PNF approach to treatment uses the principle that control of motion proceeds from proximal to distal body regions. Facilitation of trunk control, therefore, is used to influence the extremities. If this treatment paradigm is valid, gaining control of and strengthening “normal” pelvic motions should improve lower extremity function [23].

Many patients remain unable to walk or have difficulties with walking after stroke. It has been reported that only a small proportion can walk with sufficient ability to function effectively within the community. The ability to walk independently is a prerequisite for many daily activities. The pelvis plays an important role as there is simultaneous motion at the pelvis along with the trunk and hip so as to keep the progression of the gait cycle in an efficient way. In a normal gait, pelvic rotation, pelvic tilt, and pelvic translation are important elements.

Asymmetric pelvic alignment between the pelvis and the lower limbs affects the stability of the lower limbs and the trunk, making normal gait impossible. In common rehabilitation settings, pelvic PNF is not majorly implemented in improving gait performance in hemiplegics as it is not widely practiced enough even though it’s easy to administer and has proved to improve

gait performance in hemiplegics. Moreover the time constraint of a particular session with the patient gives rise to the need of proper intervention which will be effective in improving the gait performance and also implication of such interventions requires therapist's attention and time, which should be used best by giving the more beneficial treatment. Thus, this study was done to find out which treatment technique will be more beneficial to the patients aiming to achieve proper ambulation, saving their time as well as giving a treatment best suited for their needs.

MATERIALS AND METHODS

STUDY DESIGN: Experimental Study design.

TYPE OF SAMPLING: Convenient sampling.

SAMPLE SIZE: 30 subjects

Group A: Pelvic PNF Group – 15 subjects

Group B: Hip Extensor strengthening Group – 15 subjects.

INCLUSION CRITERIA:

1. Patients with MCA non-traumatic ischemic infarction more than 6 months post stroke.
2. Patients between 40-65 years of age.
3. Both male and female subjects
4. Patients with stage 4-5 on Brunnstrom recovery stage for hemiplegics.
5. Patients able to perform 10 meter walk test

EXCLUSION CRITERIA:

1. Patients with severe disabling arthritis.
2. Patients with any cognitive dysfunction.
3. Any other cardiopulmonary deficits.
4. Any other neurological deficits involving sensory function.
5. Any other musculoskeletal disorder of lower extremity.
6. Patients currently undergoing any gait training exercises.
7. Patient who did not consent for follow up.

TREATMENT DURATION: 4 weeks; 3 sessions per week - total 12 sessions

MEASUREMENT VARIABLES:

1. Gait Velocity
2. Cadence
3. Stride length

MATERIALS REQUIRED:

1. Measuring Tape/Scale
2. Stop watch
3. Chart Walkway
4. Ink

OUTCOME MEASURES:

1. 10-m walk test (ICC values of 0.99–1.00)
2. Ink foot print method for stride length (test-retest reliability ICC values of 0.96–0.98)
3. Cadence.

Procedure: After screening the subjects for the above inclusion and exclusion criteria, subjects were included in the study. A consent form was filled by the subjects. The procedure was explained to the subjects and if any doubts, they were cleared.

Subjects were conveniently divided into either of the two groups namely Pelvic PNF Group (Group A) and Hip extensor strengthening Group (Group B) by picking up a chit. Subjects in both groups were demonstrated about the exercises and the testing method. Prior to commencement of protocol gait analysis was done at the beginning of the study in which each subject was measured for the gait parameters which are Stride length, cadence and gait velocity.

Subjects in Group A received a protocol of 3 PNF techniques i.e. rhythmic initiation, slow reversal and agonistic reversal for pelvis for 30 min for 3 days a week for a total duration of 4 weeks (12 sessions). Each technique was given for 10 minutes. These procedures were done to facilitate anterior elevation and posterior depression of pelvis in a side lying position. Appropriate rest time was given to each patient in between the protocol according to the patients comfort. The elements of PNF, such as manual contact, stretch, resistance, and verbal cuing, were incorporated into the treatment scheme.

Subjects in Group B received a protocol for hip extensor strengthening exercise (HESE) program. The HESE program comprised of three exercises:

1. Bridging
2. Hip joint extensor muscle strengthening in the prone position.
3. Hip joint extensor muscle strengthening in standing position.

The program was performed four times a week for four weeks. Each session consisted of 3 sets

of 15 performances of the 3-step program lasting about 30 min, with 30 seconds of relaxation time between the sets.

Along with this conventional treatment was continued for the upper extremity and other interventions such as stretching, relaxation, proprioceptive training was carried out commonly for both the groups. The measurements of the variables i.e. Gait speed, Cadence, Stride Length was taken twice, one at the beginning of the study (Pre) and one at the conclusion of the 4 week duration (Post).

Intervention: The Protocol Tables were followed for the intervention implementation as they are provided

Statistical analysis: Descriptive and inferential statistical analyses were carried out in the present study. Results on continuous measurements were presented on Mean ± SD and results on categorical measurement were presented in number (%). Level of significance was fixed at p=0.05 and any value less than or equal to 0.05 was considered to be statistically significant. The Statistical software IBM SPSS statistics 20.0 (IBM Corporation, Armonk, NY, USA) was used for the analyses of the data. Collected data was analyzed using paired t test, to find out the significance of difference within the variables of two Groups i.e. Group A and Group B separately. Unpaired t test was employed to find out the significance of difference between the variables of Group A and Group B.

GROUP A: Pelvic PNF Protocol		
Techniques	**Duration**	**Total duration**
Rhythmic Initiation	10 min	30 min
Slow Reversal	10 min	
Agonistic Reversal	10 min	

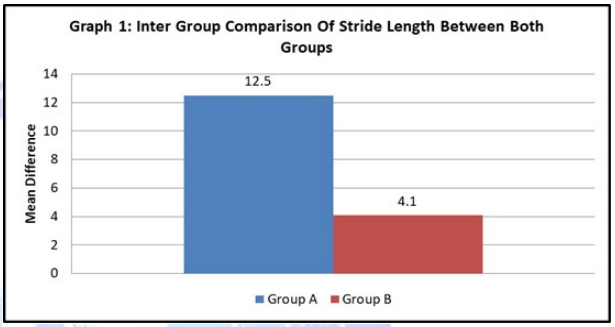
GROUP B: Hip extensor strengthening protocol	
Exercises	**Regimen**
Bridging	15 repetitions x 3 sets
Hip extension in prone	15 repetitions x 3 sets
Hip extension in standing	15 repetitions x 3 sets

RESULT

Stride Length: Table 1 and Graph 1 shows intergroup comparison of Mean differences of Stride length between both the groups using unpaired t test. Unpaired t test showed significant increases ($p < 0.05$) in Stride Length readings of Group A when compared with Group B with p-value being p = 3.76481E-06. This implicates that the intervention in both the groups was effective in improving Stride Length but Group A was more effective than Group B.

Table 1: Inter Group Comparison of Stride Length between Both Groups.

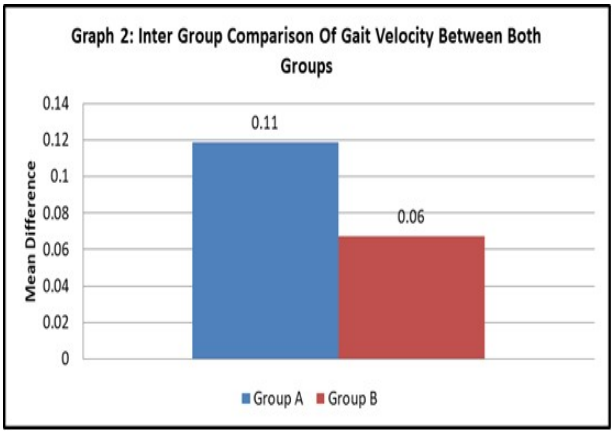
Groups	Mean Difference	Standard Deviation	t-value	p-value	Interpretation of p-value
Group A	12.5	4.44	5.84	< 0.05	Significant
Group B	4.1	3.37			



Gait Velocity: Table 2 and Graph 2 shows intergroup comparison of Mean differences of Gait Velocity between both the groups using unpaired t test. Unpaired t test showed significant increases ($p < 0.05$) in Gait Velocity readings of Group A when compared with Group B with p-value being p = 1.73161E-06. This implicates that the intervention in both the groups was effective in improving Gait Velocity but Group A was more effective than Group B

Table 2: Inter Group Comparison of Gait Velocity between Both Groups.

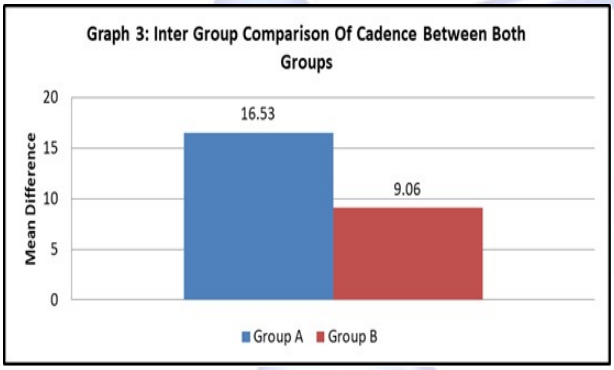
Groups	Mean Difference	Standard Deviation	t-value	p-value	Interpretation of p-value
Group A	0.11	0.02	6.02	< 0.05	Significant
Group B	0.06	0.02			



Cadence: Table 3 and Graph 3 shows intergroup comparison of Mean differences of Cadence between both the groups using unpaired t test. Unpaired t test showed significant increases ($p < 0.05$) in Cadence readings of Group A when compared with Group B with p-value being p =1.54976E-05. This implicates that the intervention in both the groups was effective in improving Cadence but Group A was more effective than Group B.

Table 3: Inter Group Comparison Of Cadence Between Both Groups.

Groups	Mean Difference	Standard Deviation	t-value	p-value	Interpretation of p-value
Group A	16.53	4.62	5.845215	<0.05	Significant
Group B	9.06	1.75			



DISCUSSION

The present study was done to compare the effects of Pelvic PNF exercises and Hip extensor strengthening exercises on gait parameters of chronic hemiplegic patients, where Group A was given Pelvic PNF exercises and Group B was given Hip Extensor strengthening exercises.

The results of this study demonstrated that the PNF techniques have significant effect on gait parameters in patients with hemiplegia. PNF is a method of neuromuscular dysfunction treatment, primarily by means of facilitating the flow of information, mainly by stimulation of proprioceptors [19].

In PNF position, sensory inputs from the periphery leads to stronger excitation of the cortical areas, leading to variations in the thresholds of a number of motor neurons, which was reflected in the motor evoked potentials [19]. In a study done by Trueblood et al (1989) it was revealed that the resisted PNF techniques have significant effect in the gait disturbances in hemiplegic patients (Trueblood et al, 1989) [23].

Intensive repetition of movement elicited by the facilitation technique (chiefly proprioceptive neuromuscular facilitation, stretch reflex) improved voluntary movement of a hemiplegic lower limb in patients with brain damage.

From these results it seems that a treatment program using hip extensor muscle strengthening movements and therapist handling provides an appropriate environment for improvement of gait ability and for motivation of patients [13]. To elicit an improvement in hemiplegic patients' stable gait, a much longer treatment period is required, and the stage and duration of stroke and a variety of forms of movement also need to be considered [20]. When a muscle contraction is resisted, that muscle's response to cortical stimulation increases [25]. From this it can be understood that for hip joint muscle power strengthening movements to influence hemiplegic patients' stable gait, several things are required at the same time: a long enough treatment period, a variety of movements and muscle power strengthening movements of the hip joint, knee joint, and ankle joint [20]. The effect of strengthening treatment on stroke patients depends on the treatment time, the movement form, and the patient's positive participation [18].

The reason why there was more significant improvement in Pelvic PNF group after four weeks of movement therapy was the order of movement and other factors during the intervention. Patients with hemiplegia usually have slower gait speeds and shorter stride lengths than do subjects without hemiplegia. The probable mechanism by which PNF could have worked is by facilitating the neuromuscular mechanism, thus a greater motor response can be attained when employing facilitating techniques in addition to resistance [35-38]. Facilitation resulted from a number of factors such as application of stretch, use of particular movement patterns and use of resistance in order to induce irradiation [38].

The improvements recorded in this study regarding stride length were due to a more efficient limb swing due to appropriate recruitment of more motor units that resulted in more efficiency of advancing paretic limb in swing and in shifting weight to the paretic limb.

The improvement in gait velocity was due to an increase in cadence accompanied by an increase in average stride length of the subjects [38].

In PNF the specific pattern of anterior elevation and posterior depression is an integral aspect when gait swing is considered. As this movement pattern of the pelvis is reinforced, it increases motor response and motor learning that occurs due the facilitatory techniques along with resistance thus leading to the improvement in the gait parameters. All these techniques help to facilitate pelvic motion and stability, and enhance gait performance indirectly through irradiation thereby improving performance of participants in the experimental group [38].

Elzbieta (2006) assessed gait kinematics in patients with hemiplegia after the PNF; and noticed the difference of the values of analyzed kinematic parameters of gait according to the norm. It was concluded that the therapy of PNF method showed improvement of the performed gait disabilities in the subject.

Thus in the present study the intervention given in both the groups was shown to be effective, but the intervention given in Group A was found to be more effective when compared to Group B. Therefore Pelvic PNF exercises are more effective in improving the gait parameters in chronic hemiplegic patients than Hip Extensor Strengthening exercises.

CONCLUSION

This study concludes that pelvic Proprioceptive Neuromuscular Facilitation technique is more effective than Hip extensor strengthening exercises in improving gait parameters such as stride length, gait velocity and cadence in chronic hemiplegic patients.

ABBREVIATIONS

PNF- Proprioceptive Neuromuscular Facilitation

HESE- Hip Extensor Strengthening Exercises

Conflicts of interest: None

REFERENCES

[1]. Dally S, and Ruff RL, Electrically induced recovery of gait components for older patients with chronic stroke, Am J Phys Med Rehabil. 2000;79:349- 60.

[2]. Thompson JE, The evolution of surgery for the treatment and prevention of stroke. The Willis Lecture, Stroke 1996;27(8):142734.

[3]. Kopito, and Jeff, A Stroke in Time. 2001;6(9).

[4]. World Health Organization, Cerebrovascular Disorders Geneva: World Health Organization. 1978.

[5]. Susan B O Sullivan and Thomas J Schmitz, Physical Rehabilitation, Fifth edition. New Delhi: Jaypee Brothers Publication; 2007;706-750.

[6]. Jeyaraj Durai Pandian and Paulin Sudhan, Stroke Epidemiology and Stroke Care Services in India, J Stroke. 2013;3-7.

[7]. D. Nagaraja, G. Gururaj, N. Girish, Samhita Panda, A.K. Roy, G.R.K. Sarma, R. Srinivasa, Feasibility study of stroke surveillance: Data from Bangalore, India, Indian J Med Res 2009;130:396-403.

[8]. Indian Council for Medical Research, Stroke: Assessment of the burden of Non-communicable diseases: Final project report, New Delhi. Indian Council of Medical Research 2004; 18-22.

[9]. Eich HJ, Mach H, Werner C, et al.: Aerobic treadmill plus Bobath walking training improves walking in subacute stroke: a randomized controlled trial. Clin Rehabil, 2004;18:640–651.

[10]. Turnbull GI, Charteris J, Wall JC: Deficiencies in standing weight shifts by ambulant hemiplegic subjects. Arch Phys Med Rehabil, 1996;77:356–362.

[11]. Mumman CM: Perceived losses following stroke. Rehabil Nurs, 1986;11:19–24.

[12]. Perry J: Kinesiology of lower extremity bracing. Clin Orthop Relat Res, 1974;102:18–31.

[13]. Bohannon RW: Strength of lower limb related to gait speed and cadence in stroke patients. Physiother Can, 1986;38:204–206.

[14]. Don S, Reiker GG, Hildebolt C, et al.: Soft-copy versus hard-copy cranial sonography: intraobserver agreement and workstation efficiency. AJR Am J Roentgenol, 1997;169:555–561.

[15]. Dean CM, Richards CL, Malouin F. Task-related circuit training improves performance of locomotor tasks in chronic stroke: a randomized, controlled pilot trial. Archives of physical medicine and rehabilitation. 2000 Apr 1;81(4):409-17.

[16]. Sharp SA, Brouwer BJ. Isokinetic strength training of the hemiparetic knee: effects of function and spasticity. Arch Phys Med Rehabil 1997;78:1231–1236.

[17]. Bohannon R, Andrews A. Correlation of knee extension torque and spasticity with gait speed in patients with stroke. Arch Phys Med Rehabil 1990;71:330–333.

[18]. Teixeira-Salmela LF, Olney SJ, Nadeau S, Brouwer B. Reducing impairment and disability in chronic stroke survivors through muscle strengthening and physical conditioning. Arch Phys Med Rehabil 1999;8:1211–1218.

[19]. Wang, Ray-Yau. Effect of proprioceptive neuromuscular facilitation on gait of patients with hemiplegia of long and short duration. J. Phys. Ther., 1994;74(12): 1108-15.

[20]. Kang KY. Effects of resistance strengthening exercise for the hip flexor and extensor functional improvement in chronic stroke patients. PTK. 2006;13(3);1017.

[21]. Basmajian JV, Wolf SL: Therapeutic exercise (5th ed). Baltimore: Williams and Wilikins, 1990;260–277.

[22]. Roerdink, M., M., Lamoth, J.C.C., Kwakkel, G., Piet, C.W., van Wieringen, P.C.W and Beek, P.J. Gait Coordination after Stroke: Benefits of Acoustically Paced Treadmill Walking. Phys. Ther., 2007;87(8):1009-1022.

[23]. Trueblood PR, Walker JM, Perry J and Gronley JK. Pelvic exercises and gait in hemiplegia. Phys Ther 1989;69:32-40.

[24]. Kumar et Al. Effect of PNF Technique on Gait Parameters and Functional Mobility in Hemiparetic Patients. Journal of Exercise Science and Physiotherapy, 2012;8(2):67-73.

[25]. Susan Adler, Math Buck, Dominiek Beckers, PNF in Practice, Springer, 3rd edition, Pg No. 60-68, 2008.

[26]. Mehrholz, J., Wagner, K., Rutte, K., Meiâner, D., Pohl, M. Predictive validity and Responsiveness of the functional modulation category in hemiparetic patients after stroke. Archv. Phys. Med. Rehabil. 2007;88(10):13141319.

[27]. Yang, Y.R., Wang, R.Y., Chen, Y.C., Kao, M.J. Dual-Task Exercise Improves Walking Ability in Chronic Stroke: A Randomized Controlled Trial. Archv. Phys. Med. Rehabil., 2007;88:1236-40.

[28]. Agarwal, V., Kumar, M., Kumar, M.R., Pandey, R. Effect of number of repetitions of weight bearing exercises on time-distance parameters in stroke. Ind. J. Physioth. Occup. Therap. 2008;2(1):57-63.

[29]. Hsu AL, Tang PF, Jan MH: Analysis of impairments influencing gait velocity and asymmetry of hemiplegic patients after mild to moderate stroke. Arch Phys Med Rehabil, 2003;84:1185–1193.

[30]. Hesse S, Reiter F, Jahnke M, et al.: Asymmetry of gait initiation in hemiparetic stroke subjects. Arch Phys Med Rehabil, 1997;78:719–724.

[31]. Bobath B: Adult hemiplegia: evaluation and treatment, 3rd ed. Oxford: William Heinemann Medical Books, 1990;20–57.

[32]. Simons DG: Reply to M.I. Weintraub. Pain, 1999;80:451–452.

[33]. Sanders G, Stavrakas P: A technique for measuring pelvic tilt. Phys Ther, 1981;61:49–50.

[34]. Cynthia C. Norkin, Pamela K. Levangie, Joint Structure and Function: A Comprehensive Analysis, 4th edition, pg 551-553.

[35]. Krebs DE, Wong D, Jevsevar D, et al.: Trunk kinematics during locomotor activities. Phys Ther. 1992;72:505.

[36]. Stokes VP, Andersson C, Forssberg H: Rotational and translational movement features of the pelvis and thorax during adult human locomotion. J Biomech 1989;22:43.

[37]. Kawahira, K., Shimodozono, M., Ogata, A. and Tanaka, N. Addition of intensive repetition of Facilitation Exercises to multidisciplinary rehabilitation promotes motor functional recovery of the hemiplegic lower limb. J. Rehabil. Med., 2004;36: 159-164.

[38]. Shimura, K. & Kasai, T. 2002. Effect of proprioceptive neuromuscular facilitation on the initiation of voluntary movement and motor evoked potential in upper limb muscles. Science Direct- Human Movement Science 2002;21:101–113.

[39]. A.Thiruppathi, P.Rajitha, V.Kiran, K.Suneel kumar; Efficacy of Proprioceptive Neuromuscular Facilitation techniques to Pelvic girdle muscles in improving gait in hemiplegic patient; JMSCR 2016;4(07).

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