

## RESEARCH REPORT

# COMPARING MUSCLE ENERGY TECHNIQUE AND HOLD RELAX IN THE MANAGEMENT OF NECK PAIN AND UPPER TRAPEZIUS TIGHTNESS

### ABSTRACT

#### OBJECTIVE

To compare the efficacy of Muscle Energy Technique (MET) and Hold Relax Technique of Proprioceptive Neuromuscular Facilitation (PNF) in non-specific neck pain and upper trapezius tightness.

#### STUDY DESIGN AND SAMPLING TECHNIQUES

Experimental Study, Randomized Control Trial.

#### STUDY SETTINGS & PARTICIPANTS

Study was conducted at reputed Institute of Physical Therapy and Hospital including students, teachers, staff, and patients with a sample size of thirty participants.

#### INTERVENTION

MET and PNF hold relax technique is applied for non specific neck pain and upper trapezius spasm.

#### OUTCOME MEASURES

Using single blinded randomization, subjects were allocated into two groups A and B. In Group A hold relax of Proprioceptive Neuro-muscular Facilitation (PNF) was applied to upper trapezius muscle while in group B Muscle Energy Technique (MET) was applied on the same muscle. Comparison is made for examining the effectiveness of both PNF and MET on pain scale and cervical ranges.

#### RESULTS

Improvements were seen in both groups but results of Hold Relax PNF technique is found to be more effective than MET. Major difference was reported pre and post treatment in the pain magnitude and neck range of motion.

#### CONCLUSION

The result of this study supports the application of PNF technique for relieving non-specific neck pain and upper trapezius muscle spasm.

#### Keywords

Muscle Energy Technique, Proprioceptive Neuromuscular Facilitation, Hold Relax Techniques, Non-specific Neck Pain, Upper Trapezius Spasm, Pain Magnitude, Randomization

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## INTRODUCTION

Neck pain is peculiar prevailing reason for musculoskeletal problem. Pain can arise from a number of reasons that may involve any tissue of the neck influencing 60-70% of the overall population at various times in their lives<sup>1</sup>. Neck pain is very common, however, the uplifting news is that the majority of neck pain is not brought on by serious disease. Neck pain is common among workers, teachers, and students, has a wide range of reasons. While neck pain cannot generally be cured, there is various treatment options available. Neck pain without any underlying disease or abnormal anatomical structure is termed as non-specific neck pain and it can result from postural and mechanical factors such as sprains and strains of the muscles or ligaments in the neck. Symptom of non-specific neck pain includes pain develops in the neck and spread from the bottom of skull down to the upper trapezius region and moving the neck becomes painful<sup>1</sup>. Upper trapezius tightness can also cause neck pain as these muscles are highly susceptible to overuse and by consistently overusing the muscle group can lead to muscle tightness and irritation as recurring motions do not permit the affected tissue to relax between movements<sup>2</sup>.

Physical therapy management of neck pain and upper trapezius tightness can include wide range of interventions including electrotherapeutic modalities, stretching and strengthening exercises, myofascial release, traction and manual therapy. There are varieties of manual therapy treatment options available that can be used to decrease neck pain and improve neck ranges. These treatments may include trigger point therapy, mobilization and manipulation. Muscle Energy Technique (MET) is one of the techniques that are used to treat musculoskeletal dysfunctions. In muscle Energy Technique the affected person can actively contract the muscles from a controlled position in a specific direction in opposition to the force applied<sup>3</sup>. MET are widely used to treat muscle hyper-tonicity and muscular tightness and it is also effective technique in the management of joint dysfunction and in breaking joint capsule adhesions. MET is found to be effective in lengthening potentially shortened postural muscle, methods through which MET may turn out in improved joint range of motion stay unproven, some authors of MET claim that "MET produce relaxation of the affected muscles due to inhibition of motor activity through the Golgi tendon organs"<sup>4</sup>.

Proprioceptive Neuromuscular Facilitation (PNF) is another technique situated in the literature as more capable technique to bring muscle relaxation and to enhance range of motion<sup>5</sup>. PNF stretching comprises of different techniques that all incorporate alternating periods of contraction and relaxation of agonist and antagonist muscle.

Among PNF techniques, the Hold-Relax technique, uses an isometric contraction of muscles and is commonly used in clinics to relax muscle, relieve pain, and to improve the ROM of joints<sup>6</sup>. PNF employs the proprioceptive system of body to inhibit or promote soft tissue contraction. Dorothy Voss, one of the proponents who practiced PNF, explained it as "A method of promoting or hastening the response of the neuromuscular mechanism through the stimulation of proprioceptors"<sup>6</sup>.

In this research we compare the effects of hold-relax technique of PNF and MET for neck pain and upper trapezius tightness along with the application of techniques. Postural guidance given to patients as poor posture leads to the development of musculoskeletal dysfunctions. Unfortunately, there is not much evidence to support the effectiveness of Muscle Energy Technique. A research was conducted to explore the after effect of Muscle Energy Technique on cervical range of motion, this study comprises of seven treatment sessions with three repetitions of Muscle Energy Technique for four weeks utilizing 5-second contractions and result of the study revealed, case group range of motion was improved as compare to the control group which presents minimal or no change<sup>7</sup>. Fryer G, Ruzkowski W<sup>8</sup> proved that Five-second contractions of Muscle Energy Technique demonstrate significant results with application on restricted active rotation at the atlanto-axial joint.

In another study by Lenehan et al<sup>9</sup> found that single application of Muscle Energy Technique on thoracic spine is effective in correction of rotation limitation and the study suggest that the appliance of Muscle Energy Technique is recommended to improve limited spinal rotation. In an examination of twenty six individuals with confined range of motion of lumbar expansion treated with Muscle Energy Technique two times every week for four weeks, Muscle Energy Technique found to fundamentally expand the lumbar extension range of motion and supporting Muscle Energy Technique as proper therapy for enhancing lumbar extension<sup>10</sup>. In another study done by Schwerla et al for the treatment of chronic neck pain, they compare MET with placebo ultrasound and found that the group receiving MET had reduce pain when compared to placebo group<sup>11</sup>. A comparative study of neck muscle exercises therapy with Proprioceptive Neuromuscular Facilitation technique conclude that Proprioceptive Neuromuscular Facilitation found to be effective approach to reduce pain and enhance muscle strength in patient suffering from chronic neck pain<sup>12</sup>. Moon et al. conduct a study to compare the effects of functional electrical stimulator and Proprioceptive Neuromuscular Facilitation treatment on thirty subjects, the group on which Proprioceptive Neuromuscular Facilitation is applied shows greater improvement in upper limb function<sup>13</sup>. Another study conclude that exercise

program that include Proprioceptive Neuromuscular Facilitation techniques found to be more effective in improving function of patient with myofascial pain syndrome<sup>14</sup>.

Another study comparing the effectiveness of Muscle Energy Technique and static stretching on neck pain and active cervical range of motion conclude that Muscle Energy Technique was more effective than static stretching in treating neck pain and improving range of motion<sup>15</sup>. Study on efficacy of Muscle Energy Technique versus conventional therapy in low back pain of Sacroillitis origin, Muscle Energy Technique group demonstrate more improvement against conventional therapy group<sup>16</sup>. Studies conducted on thirty-two patients with myofascial pain syndrome were divided into two groups, Case group received Proprioceptive Neuromuscular Facilitation with relaxation therapy for upper trapezius and shoulder stabilizing exercises and control group received only the general physical therapies. Study was measured on Visual Analog Scale (VAS), Pressure Pain Threshold (PPT), the Neck Disability Index (NDI), and the constant Mosley scale. The result showed significant differences between the groups. They concluded that Proprioceptive Neuromuscular Facilitation is effective in improving the function of myofascial pain syndrome<sup>17</sup>. Another study was conducted on assessment of Range of Motion (ROM) in external rotation of athletes' shoulders. They compared effects of the contract-relax and hold-relax Proprioceptive Neuromuscular Facilitation (PNF) stretching with control group. There were thirty participants including adults of both genders aged 25 to 50 years. They were divided into three groups. Ten participants in each group were assigned. One group received contract-relax-contract (CRC) and the second group received hold-relax-contract (HRC) and remaining ten participants included in control group. They measured range of motion for external rotation of the shoulder with goniometer before and after six weeks of training. Results revealed that increase in range of motion from prior and after the test in CRC group (+14.60 degrees) and HRC group (+13.50 degrees), but there was no change in control group (+0.30 degrees). The enhancement in range of motion was alike among the HRC and CRC groups<sup>18</sup>. Another study was conducted to compare immediate as well as medium-term effects of three stretching methods (including proprioceptive neuromuscular facilitation, passive and active stretching) on the knee flexion after total knee replacement. There were 117 patients and randomly divided into three groups. First group received active stretching including thirty two subjects and second group received passive stretching including thirty five subjects and remaining thirty three subjects received Proprioceptive Neuromuscular Facilitation stretching. This research showed that all methods of stretching are effective for improving range of

motion<sup>19</sup>. A study was conducted to find the efficacy of muscle energy technique (MET) contrast by means of corticosteroid injections (CSIs) for chronic lateral epicondylitis (LE) and it revealed Muscle Energy Technique and Corticosteroid Injection both showed improvement in strength, pain, and function but Muscle Energy Technique (MET) reported effective treatment for lateral epicondylitis (LE)<sup>20</sup>. A research was conducted on sixty-one subjects to compare the Muscle Energy Technique (MET) for the glenohumeral joint (GHJ) horizontal abductors and Muscle Energy Technique for the glenohumeral joint external rotators to improve glenohumeral joint range of motion (ROM) in baseball players. They were divided into three groups: Muscle Energy Technique for the glenohumeral joint horizontal abductors (including nineteen subjects), Muscle Energy Technique for the glenohumeral joint external rotators (including twenty two subjects), and control group (including twenty subjects). They measured range of motion before and after treatment and reported that the Muscle Energy Technique for the horizontal abductors significantly increase in glenohumeral joint horizontal adduction range of motion compared to the control group and a greater increase in internal rotation range of motion post-intervention compared to the group treated with the Muscle Energy Technique for the external rotators and the control group<sup>21,22</sup>.

Neck pain is common problem among people who works for prolong hours and it is strongly recommended to motivate patient to seek conservative treatment such as manual therapy in which there is wide range of techniques that are used to relief pain. In this study, Muscle Energy Technique and Hold-Relax technique of Proprioceptive Neuromuscular Facilitation is used to identify the effectiveness of one technique over another.

## METHODOLOGY

### Population and Study Sample

Population of study comprises of students, workers and patients who had complain of neck pain without any underlying disease and pathology and having upper trapezius tightness. Sample size of 30 patients was collected. Simple Random Sampling Technique is used in this study. Single blinded randomization was used for the subjects to be allocated into two groups; A and B. In Group A, Hold Relax of Proprioceptive Neuromuscular Facilitation was given to upper trapezius muscle, and on group B Muscle energy technique is applied on the same muscle. A questionnaire was given outlining the eligibility criteria for the study to screen the subjects for any known medical condition of neck for example; history of neck trauma, congenital deformities, chronic conditions like arthritis. Selected participants were evaluated for pain using VAS scale and restricted neck range of motion due to upper trapezius tightness using goniometer. Both

Ranges and pain scales were recorded at initial assessment day and re-assessed after four weeks of treatment.

#### Inclusion Criteria

- o Pain positive on VAS (mild to moderate)
- o Age between 18-35 years
- o Gender both male and female
- o Working 6-10 hours/day (Job or study)

#### Exclusion Criteria

- o Suffering with derangement disorder
- o Osteoarthritic changes such as reduced intervertebral disc spaces and osteophyte formation
- o History of cervical trauma
- o Congenital deformities such as torticollis, schro-mal nodule
- o Infectious diseases

#### ETHICAL CONSIDERATION

The purpose of this study has been explained and a written informed consent was obtained from all the participants. Detailed explanation of study protocol and written informed consent was obtained from the researcher and approval was taken by the Ethical Review Board.

#### RESULTS

The data was evaluated and analysed at Statistical package for social science (SPSS-20).

Sample size of 30 participants was included via Simple random technique.

In this study we apply the two techniques over upper trapezius muscle (upper trapezius tightness)

Study includes 14 males and 16 females ( table 1) of age between 19-30 years; all participants were healthy and are not physically or mentally disabled. On the basis of cervical ROM we consider the following movements after application of techniques over cervical spine

- I. Neck flexion
- II. Neck extension
- III. Neck right rotation
- IV. Neck left rotation
- V. Neck right side bending
- VI. Neck left side bending

Assessment of participants was done on the basis of cervical spine (ROMs) and Pain Management on

VAS scale.

After application of both the techniques it was observed that both techniques were effective in order to relieve pain and increase ROM.

**Table 1**

	N	Minimum	Maximum	Mean	Std. Deviation
age of participant	30	19.00	29.00	24.00	2.57
gender of participant	30	1.00	2.00	1.53	0.50
What is your occupation/ profession	30	1.00	3.00	2.56	0.56
Working hours for specified occupation profession	30	1.00	4.00	2.46	1.07
Valid N(list wise)	30				

**Table 2**

**Statistical comparison of Cervical Range of motion after application of both techniques**

S.No	RANGE OF MOTION	PNF		MET	
		Frequency	Percent	Frequency	Percent
1	Flexion	5	25.4	8	50.2
		5	41.2	3	23.1
		3	17.6	2	15.4
		2	11.8	2	15.4
		0	0	0	0
2	Extension	2	9.8	6	34.8
		6	47.1	5	38.5
		5	29.4	2	15.7
		2	11.8	1	7.7
		0	0	1	0
3	Left	2	11.8	2	15.4
		2	11.8	3	7.7
		3	5.9	2	15.4
		8	47.1	2	15.4
		0	0	3	23.1
	Right	0	0	2	15.4
		2	11.8	1	7.7
		1	5.9	5	23.1
		4	35.3	1	7.7
		5	29.4	2	15.4
4	Left	1	5.9	2	15.4
		2	10.6	4	30.8
		6	11.8	3	9.7
		3	8.8	7	53.8
		5	5.9	1	7.7
	Right	1	47.1	1	7.7
				3	23.1
		5	29.4	7	40.5
		3	25.4	4	30.8
		5	29.4	4	30.8
		2	11.8		

Results for Range of Motions after comparison of both techniques is made PNF is more accurate and reliable to increase the range of motion of cervical spine and to release upper trapezius tightness(table 2)

Results of Visual Analog Scale shows that the mean Rank for PNF (Hold relax) in VAS Scale is high therefore PNF is much better in relieving pain than Muscle energy technique (table 3a).

**Table 3a.**

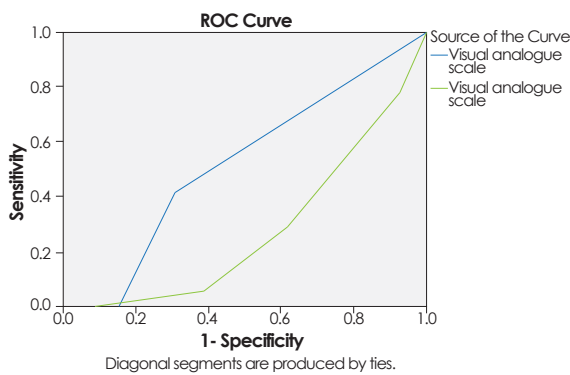
Technique applied	N	Mean Rank	Sum of Rank
MET	Negative Ranks	14 <sup>a</sup>	8.50
	Visual analogue scale - Positive Ranks	0 <sup>b</sup>	.00
	Ties	1 <sup>c</sup>	.00
	Total	15	
PNF	Negative Ranks	15 <sup>a</sup>	7.00
	Visual analogue scale - Positive Ranks	0 <sup>b</sup>	.00
	Ties	0 <sup>c</sup>	.00
	Total	15	145.00

a. Visual analogue scale < Visual analogue scale  
 b. Visual analogue scale > Visual analogue scale  
 c. Visual analogue scale = Visual analogue scale

**Table 3b.**

Technique applied	Visual analogue scale - Visual analogue scale
MET	Z -3.08 <sup>a</sup>
	Asymp. Sig. (2-tailed) 0.002
PNF	Z -3.71 <sup>b</sup>
	Asymp. Sig. (2-tailed) 0.000

a. Wilcoxon Signed Ranks Test  
 b. Based on positive ranks.



Overall, the results (table 3b) shows that both techniques are effective in reducing pain and increasing cervical range of motion but PNF techniques show more significant results as compared to MET.

**DISCUSSION**

Muscles are dispersed throughout the human body and they are the most important energetic tissues that maintain posture and helps in the movements of the musculoskeletal system. Neck pain is one of the most common problems in our society. Upper trapezius is the most probable postural muscle which gets shortened in most of the cases. There are several ways to treat upper trapezius tightness. In this study two techniques Muscle energy Technique (MET) and Hold Relax technique of Proprioceptive Neuromuscular Facilitation (PNF) is compared. There is a lack of evidence about the effectiveness of Muscle Energy Technique (MET) when compared with the stretching technique of Proprioceptive Neuromuscular Facilitation (PNF).

Past researches have typically demonstrated that most frequent treatment technique PNF which is used to treat physical dysfunction resulting from any damage or disease<sup>23, 24</sup>. A study conducted in 2004 showed improvement in hamstring flexibility with the application of PNF technique<sup>25</sup>. Another study conducted by Gonzakz Rave et al, showed

increase in the ranges of motion of the shoulder and hip joints in 51 patients with the application of Proprioceptive Neuromuscular Facilitation technique. The result of our study indicated that the neck pain decreased and range of motion is increased in group who performed isometric exercises of neck. On the other hand, Muscle Energy Technique (MET) is also effective in decreasing pain and dysfunction. Muscle Energy Technique (MET) is also used to stretch a shortened muscle and strengthen a weakened muscle. There is a lack of evidence to make any absolute result about the efficacy of Muscle Energy Technique (MET) on neck pain and upper trapezius tightness. Overall we found minimal evidence that Muscle Energy Technique (MET) reduce pain on upper trapezius tightness.

In this study after comparison of both techniques, our analysis proved that Proprioceptive Neuromuscular Facilitation is more effective than Muscle Energy Technique. In the present study, the experimental group which received Proprioceptive Neuromuscular Facilitation technique showed statistically significant result in VAS, having Z score is -3.71 while Muscle Energy Technique has Z score is -3.08. And in our study sum of rank of Proprioceptive Neuromuscular Facilitation are 145 while on other hand Muscle Energy Technique has 80 sum of rank. Basically this study is based on effectiveness of both Proprioceptive Neuromuscular Facilitation and Muscle Energy Technique on cervical range of motion, ranges include cervical flexion, extension, right rotation, left rotation and right and left side bending.

There is lack of evidence found on the Muscle Energy Technique in comparison with other manual therapy treatment. In our study it also shows that there is minimal effect of Muscle Energy Technique on neck pain and cervical range of motion. On other hand, our study shows good effect of Proprioceptive Neuromuscular Facilitation in the management of pain in VAS scale and in cervical ranges. Whereas, our study also shows some positive effect of Muscle Energy Technique like Muscle Energy Technique is much effective in left rotation and Proprioceptive Neuromuscular Facilitation effect more in right rotation. In this study ROC curve shows the activity of pain on Vas scale in which the mean rank for Proprioceptive Neuromuscular Facilitation (Hold relax) in Vas scale is high, which proves that Proprioceptive Neuromuscular Facilitation is much pain relieving in upper trapezius tightening than Muscle Energy Technique.

This study wined up that both treatment techniques, Muscle Energy Technique (MET) and Proprioceptive Neuromuscular Facilitation (PNF) were effective on neck pain and muscular tightness but Proprioceptive Neuromuscular Facilitation is more effective. Further studies are required to know the

comparison of Muscle Energy Technique and Proprioceptive Neuromuscular Facilitation in other joints or other areas of body. From all of the above, we conclude that in the management of pain and to improve cervical range of motion Proprioceptive Neuromuscular Facilitation technique is much effective than Muscle Energy Technique.

### CONCLUSION

Statistical analysis shows for group A and B, there was mild significant effects after applying PNF Technique than MET.

Hence, PNF (Hold relax technique is much effective than MET in relieving of muscle tightness and management of pain in upper trapezius tightness and pain.

### REFERENCE

- [1] Damgaard P, Bartels EM, Ris I. Evidence of physiotherapy interventions for patients with chronic neck pain: a systematic review of randomised controlled trials. *Pain*. 2013; 567175.
- [2] Helping upper-trapezius pain [Internet]. 2006. Available from: <http://www.idealit.com/fitness-library/trapezius-strain-upper-trapezius-pain>
- [3] Chaitow L, Liebenson C. *Muscle Energy Technique*. 2nd ed. Edinburgh: Churchill livingstone; 2001.
- [4] Denslow JS, Korr IM, Kreams AD. Quantitative studies of chronic facilitation in human motoneuron pools. *Am J Physiol*. 1947;150(2):229-238.
- [5] Sharman MJ, Cresswell AG, Riek S. Proprioceptive neuromuscular facilitation stretching: mechanisms and clinical implications. *Sports Med*. 2006;36(11):929-939.
- [6] Burton L, Brigham H. Proprioceptive neuromuscular facilitation: the foundation of functional training [Internet]. 2013. Available from: [http://www.functionalmovement.com/articles/Screening/2013-07-04\\_proprioceptive\\_neuromuscular\\_facilitation\\_the\\_foundation\\_of\\_functional\\_training](http://www.functionalmovement.com/articles/Screening/2013-07-04_proprioceptive_neuromuscular_facilitation_the_foundation_of_functional_training)
- [7] Schenk R, Adelman K, Rousselle J. The effects of muscle energy technique on cervical range of motion. *J Man Manip Ther*. 1994;2(4):149-155.
- [8] Burn DK, Wells MR. Gross range of motion in the cervical spine: the effects of osteopathic muscle energy technique in asymptomatic subjects. *J Am Osteopath Assoc*. 2006;106(3):137-142.
- [9] Lenehan KL, Fryer G, McLaughlin P. The effect of muscle energy technique on gross trunk range of motion. *J Osteopath Med*. 2003;6(1):13-18.
- [10] Schenk R, MacDiarmid A, Rousselle J. The effects of muscle energy technique on lumbar range of motion. *J Man Manip Ther*. 1997;5(4):179-183.
- [11] Schwerla, F., Bischoff, A., Nürnberger, A., Genter, P., Guillaume, J. and Resch, K. Osteopathic Treatment of Patients with Chronic Non-Specific Neck Pain. *Res Complem Med*. 2008;15(3):138-145.
- [12] Rezasoltani A, Khaleghifar M, Tavakoli A, Ahmadi A, Minoonejad H. The effect of a proprioceptive neuromuscular facilitation program to increase neck muscle strength in patients with chronic non-specific neck pain. *J Phys Ther Sci*. 2010;3(1):59-63.
- [13] Moon SH, Hong WS, Kim SS, et al. The impact of functional electrical stimulus and proprioceptive neuromuscular facilitation to scapula adductor on upper limb functions and gait of the patients with stroke. *J Int Acad Phys Ther Res*. 2010;1(2):143-148.
- [14] Lee JH, Park SJ, Na SS. The effect of proprioceptive neuromuscular facilitation therapy on pain and function. *J Phys Ther Sci*. 2013;25(6):713-716.
- [15] Mahajan R, Kataria C, Bansal K. Comparative effectiveness of muscle energy technique and static stretching for treatment of subacute mechanical neck pain. *Int J Health Rehabil Sci*. 2012;1(1):16-24.
- [16] Bindra S. A study on the efficacy of muscle energy technique as compared to conventional therapy on lumbar spine range of motion in chronic low back pain of sacroiliac origin. *Hum Bio Rev*. 2013;2(4):336-349.
- [17] Hindle KB, Whitcomb TJ, Briggs WO, Hong J. Proprioceptive neuromuscular facilitation (PNF): its mechanisms and effects on range of motion and muscular function. *J Hum Kinet*. 2013;31:105-13.
- [18] Decicco PV, Fisher MM. The effects of proprioceptive neuromuscular facilitation stretching on shoulder range of motion in overhand athletes. *J Sports Med Phys Fitness*. 2005;45(2):183-187.
- [19] Chow TP, Ng GY. Active, passive and proprioceptive neuromuscular facilitation stretching are comparable in improving the knee flexion range in people with total knee replacement. *Clin Rehabil*. 2010;24(10):911-918
- [20] Kucuksen S, Yilmaz H, Salli A, Ugurlu H. Muscle energy technique versus corticosteroid injection for management of chronic lateral epicondylitis. *Arch Phys Med Rehabil*. 2013;94(11):2068-2074.
- [21] Moore SD, Laudner KG, McLoda TA, Shaffer MA. The immediate effects of muscle energy technique on posterior shoulder tightness: a randomized controlled trial. *J Orthop Sports Phys Ther*. 2011;41(6):400-407.
- [22] Lewit K. Postisometric relaxation in combination with other methods of muscular facilitation and inhibition. *Man Med*. 1986;2:101-104.
- [23] Ma SY, Kim HD. Effect of a PNF training program or functional assessment measures and gait parameters in healthy older adults. *J Korean Soc Phys Ther*. 2010;22:39-45.
- [24] Ji SK, Lee MH, Kim MK, et al. The effect of CI technique in PNF on the muscle activity, fatigue and balance in memiplegic patient. *J Korean Soc Phys Ther*. 2009;21:17-24.
- [25] Schuback B, Hooper J, Salisbury L. A comparison of a self-stretch incorporating proprioceptive

neuromuscular facilitation components and a therapist-applied PNF-technique on hamstring

flexibility. J Physio Ther. 2004;90(3):151-157.

