Middle-East Journal of Scientific Research 16 (5): 595-601, 2013
ISSN 1990-9233

DOI: 10.5829/idosi.mejsr.2013.16.05.75158

What Happens for Spinal Reflexes in Frightening Conditions?

Abbas Rahimi

Department of Physiotherapy, Rehabilitation Faculty,
ShahidBeheshti University of Medical Sciences, Tehran, Iran

Abstract: Nervousness and anxiety cause both physical and mental problems and has shown to propose spinal reflex modulation during intimidating conditions. This study aimed to investigate if the H-reflex as a well-known spinal reflex influenced by postural anxiety and distress. The Hoffmann (H) reflex of twenty healthy young females with an anxiety score lower than 42 (based on the Spielberger's questionnaire) were recorded in four positions including the standard prone lying, standing on level ground, standing on the center of a one-meter height stool and on the edge of the one-meter height stool as two frightening conditions. The latency, amplitude and intensity needed to record the H-reflex were measured in the four mentioned positions. The results of this study showed that, in terms of the latency of the H-reflex, no significant difference was found among the four tested positions (p=0.169). However, the amplitude of the reflex showed significant differences between any of the positions when compared to the reference (prone lying) position (p=0.001). In addition, there was significant difference among all four positions in terms of the intensity needed to record the H-reflex (p=0.034). The Bonferoni test revealed that the significant difference existed only between the standing at the edge of the height relative to the standard prone lying position (p=0.041).The results of this study confirmed that any postural perturbations will result in brain activities and affect more on the amplitude of the H-reflex than the latency. These findings might be helpful in a better understanding of the balance in healthy people and people suffering from anxiety, fear of falling, elderly persons and also patients with psychological disorders.

Key words: Postural Anxiety · H-Reflex, Stability Threatening Conditions · Electromyography

INTRODUCTION

Different physical and mental reactions are usually presented from human when face environmental pressures such as anxiety and fears [1]. Recently, both evolutionary and clinical physiologists have studied these issues from their points of views. Fear and anxiety warn people to be ready for facing the problems. People need postural control and maintaining balance in their activities of daily living (ADL). Maintaining balance results from inputs among visual, vestibular and somato-sensory signals aiming on the compensation of its postural perturbations. Although postural control mainly originates from physiologic agents, psychological factors such as anxiety and fear of falling are also affective on it [2-4]. Balance perturbation and falling results in both serious physical and mental complications, of which brain trauma and multiple fractures (e.g. femoral neck fracture) are the most serious ones [5]. Recurrent falling is one of the outcomes of falling which is easily ignored. Furthermore, lonely living, fatness, recognition problems, having no physical activities, depression, weak balance and economic looseness are some more complications of falling. More fear of falling causes more rates of accidents. In Brief, falling limits peoples' activities and breaks their independencies [6-8]. Maki *et al*. [2] firstly reported that postural anxiety may affect on postural controls. Brown and Frank [7] reconstructed a threatening position with increasing the height of the standing level. A spinal motor reflex, which is shown by the H-reflex via electrical

Corresponding Author: Dr. Abbas Rahimi, Department of Physiotherapy, Faculty of Rehabilitation, Shahid Beheshti University of Medical Sciences, Damavand Avenue, Opposite to Bou-Ali hospital, Tehran 1616913111, Iran.
Tel: +98 21 77561721-4, Fax: +98 21 77561406.

stimulation of the calf muscles, plays a key role in postural control. Stretch reflex plays an adaptation role in environmental changes. The Hoffmann reflex (H-reflex) is regulated by different postural tasks [9] and also being a task new and hard [10]. For instance, the amplitude of the H-reflex may vary during changing the position from lying to standing, or during different phases of walking and running. Wada *et al.* [5] used an anxiety questionnaire and showed significant changes in anterior-posterior (AP) stability index. No literature was found to focus on the effect of postural anxiety on balance control and H-reflex parameters.

Postural anxiety is defined as relatively stable individual characteristics determining the amount of tendency of persons to be in danger of involvement of anxiety. These characteristics differentiate people from others in high anxiety conditions such as being in danger or any threatening conditions. Any reaction in these conditions is associated with obvious anxiety and severe emotional stresses [11]. Therefore, the current study aimed to find out if postural anxiety may affect on the H-reflex parameters as a simple spinal reflex.

MATHERIALS AND METHODS

Setting: This quasi experiment was carried out in Research Center of the faculty of rehabilitation, ShahidBeheshti University of medical sciences, Tehran, Iran.

Subjects: Twenty healthy university female students with an average age of 21.5±2 years old and weight of 58.3±9 kg and the height of 166±7 cm with the anxiety score lower than 42 (based upon the Spielberger's questionnaire) were recruited in this quasi experimental study. The subjects were excluded if they showed a history of nervous system disorders, ears' internal organ diseases, musculo-skeletal disorders, psychological diseases, severe anaemia, dizziness or a history of falling during the last six months. A written consent form was signed by all subjects and their personal information was recorded in a self-constructed questionnaire. An electromyography tool (EMG, Medelec/TECA, Oxford Instruments Medical) was used to obtain the H-reflex of the Soleus muscle of the dominant leg of all subjects.

Outcome Measurements: The amplitude and latency of the H-reflex and the intensity needed to record the H-reflex were obtained in four positions including the standard prone lying, standing on level ground, standing on the centre of a one-meter height stool and standing on the edge of the stool. The last two conditions were supposed to be the threatening conditions to change the H-reflex parameters [4, 12].

Research Technique: The EMG system was calibrated based on its software orders. The duration of the stimulation was 1 millisecond and the frequency was set on 0.5Hz (one twitch every two seconds). The gain was set based on amplitude's changes in subjects between 0.5-5 mV/Div and the high-pass filter on 2 Hz. and the low-pass filters on 10 KHz. To reduce the effects of test order, the test positions were carried out randomly and all subjects were tested in a defined time and place of the test. A pilot study was carried out on 6 subjects, twice a day in a threatening condition to find out the effects on the first-height phenomenon. The paired *t*-test showed no significant difference between two times test and it was deduced no first-height effect (p=0.1).

To record the H-reflex, the posterior tibial nerve was stimulated on the sites mentioned in literature [12-14]. The active electrode was placed on the middle of the line that connects the medial maleolous of the ankle to the medial popliteal fold of the knee. The reference electrode was placed 2-3 Cm below the active electrode on the gastrocnemius muscle. The ground electrode was also fastened around the leg between the recording and stimulating electrodes. The skin of the electrode sites were shaved and cleaned. Then, the electrodes were placed at the above-mentioned sites and low amplitude current was applied. The amplitude increased so that the low amplitude H-reflex was appeared. The intensity was then slowly increased to see the highest amplitude H-reflex. An average of 10 H-reflex in each position was recorded and used for comparison (Figure 1). In standard position, the patient was in prone position and the ankle remained out of the bed while a small pillow was placed under his/her ankle joint. At the second position, the subjects were asked to stand on level ground without detaching the electrodes from his/her body and the test was repeated. To simulate a threatened situation, the subjects were asked to stand on the centre and the edge of a stool with a 100-Cm height and 70 Cm width separately. To exclude the first height effect, the last tests were carried out twice. The subjects were tested with eyes open while starring at a point on the wall with one meter distance. To reduce the danger of falling of the subjects, they were supported with a 20-cm distance by a colleague.

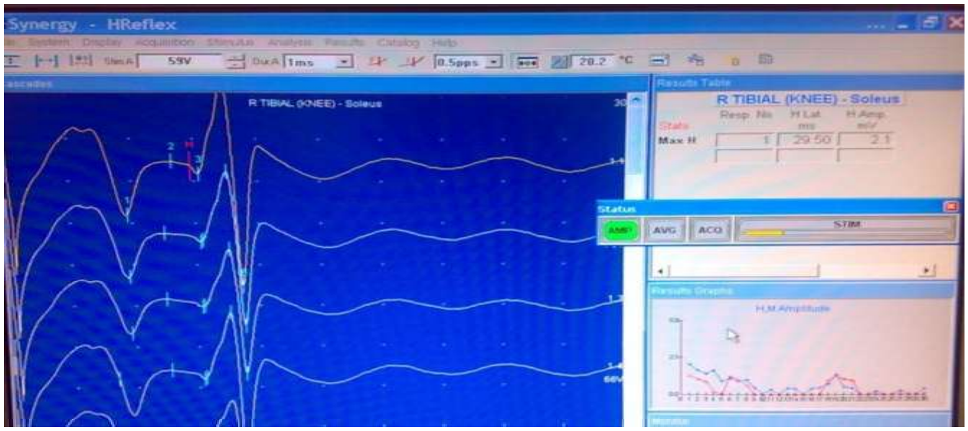

Fig. 1: The H-reflex graph recorded by the EMG tool.

The Repeatability of the Test: An expert physiotherapist measured all the H-reflex parameters in the test. A pilot study was carried out on six subjects and the H-reflex parameters were recorded three times and the ICC was calculated. The alpha (α) Chronbach was 0.86 that showed a high level correlation and ensured the researchers that the method used in this study was repeatable enough to be applied in more subjects.

Statistical Analysis: A single factor ANOVA (Repeated Measures) was used to find out if there is any difference among test positions. The Bonferoni Post-hoc technique was used to find out the data which was different from others. The SPSS statistical software (version 16) was used for statistical analysis of the study.

RESULTS

As Table 1 shows, there was no significant differences in terms of the latency among all four postures (p=0.169) (Figure 2). However, the amplitude of all positions, showed significant differences when compared to the standard prone lying (p=0.001). In addition, only in standing at the edge of the one-meter height stool, the amplitude of H-reflex showed significant difference when compared to the standing on level ground (p=0.001) (Table 2). Table 3 showed a significant difference for the intensity needed to record the H-reflex among four positions (p=0.034). The Bonferoni technique showed the significant difference only between standing at the edge of the stool relative to the standard prone lying position (p=0.043).

Table 1: The descriptive indices for latency of the H-reflex in the four positions

	Indices		
Positions	Number of subjects	Mean ±SD	*P* value
Prone lying (standard)	20	28.34 ± 0.98	*P*=0.169
Standing on level ground	20	28.38 ± 1.07	
Standing on the center of a one-meter height stool	20	27.27 ± 1.29	
Standing at the edge of a one-meter height stool	20	28.65 ± 1.20	

Table 2: The descriptive indices for amplitude of the H-reflex in the four positions

	Indices		
Positions	Number of subjects	Mean ±SD	*P* value
Prone lying (standard)	20	2.62 ± 1.05	*P*=0.001
Standing on level ground	20	1.98 ± 0.74	
Standing on the center of a one-meter height stool	20	1.82 ± 0.68	
Standing at the edge of a one-meter height stool	20	1.62 ± 0.54	

Table 3: The descriptive indices for intensities needed to record the H-reflex in the four positions

	Indices		
Positions	Number of subjects	Mean ±SD	*P* value
Prone lying (standard)	20	49.05 ± 10.37	*P*=0.034
Standing on level ground	20	45.85 ± 10.53	
Standing on the center of a one-meter height stool	20	47.40 ± 10.88	
Standing at the edge of a one-meter height stool	20	45.70 ± 10.14	

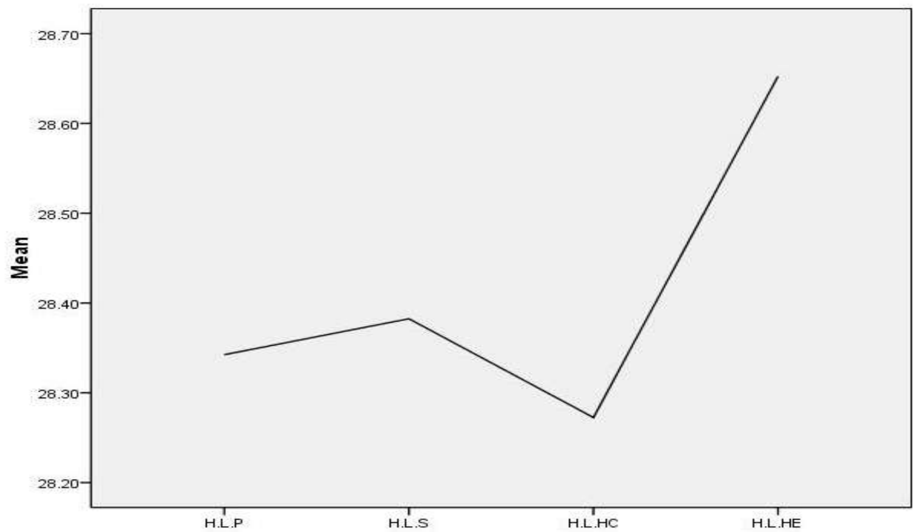

Fig. 2: H-reflex latency in the four positions
H.L.P: H-reflex in prone lying position H.L.S: H-reflex in standing position
H.L.HC: H-reflex in the center of the height H.L.HE: H-reflex at the edge of the height.

To find out any first-height effects, the analysis showed no significant difference between the two tests carried out in threatening conditions (p=0.1).

DISCUSSION

The results showed a significant difference existed in amplitude and the intensity needed to record the H-reflex among four positions, while no significant difference was found in the latency of H-reflex. This reveals that in threatening positions (e.g. standing at the edge of a height) the reflexes amplitude is modulated when compared to the standard prone lying position or standing on level ground. It should be noticed that due to the significant reduced amplitude of the H-reflex in standing position relative to the prone lying position, it can be deduced that the amplitude changes in anxiety conditions occurs independently from the positions of the subjects when testing.

In agreement with the previous studies, the results of the current study confirm changing the sensitivity of muscle spindles resulting in H-reflex modulation when one increases mental excitations [12]. Almost all studies in this field have discussed the correlation between the effects of anxiety on postural controls; very few studies have focused on the effects of postural anxiety on the H-reflex. H-reflex is a well-known spinal reflex with amplitude; latency and the intensity needed to record it. The H-reflex parameters have frequently been discussed in electromyographic studies. Since the amplitude of the H-reflex is influenced by the reciprocal physiologic effects of both the central and peripheral nervous system, it seems to be suitable for evaluation of specific sensorimotor issues [15]. Sibley *et al*. [12] have found some significant issues regarding the effects of body postures, muscle contraction and cutaneous stimulation on the H-reflex [12]. In agreement with Llewellyn *et al*. [10], the current study confirmed that increased anxiety modulates the H-reflex more than hard works. When somebody is placed in threatening conditions, the irritability of his/her spinal reflex is changed via reduced H-reflex parameters of the Soleus muscle. This might mainly be due to more contribution of brain cortex into postural control in threatening conditions. Mcllory *et al*. [16] reported increased cortical somatosensory evoked potential as well as reduced H-reflex amplitude following postural challenges. They reported a more supra-segmental control as the main source of these findings. During the last two decades, it has been proved that segmental system changes during ADL such as walking, running and jumping and the H-reflex's parameters are changed too [12]. Some previous studies have focused on the relationship between the H-reflex parameters when evaluating the irritability of the motor neuron pools in different human muscles during sitting, standing, functional motor tests, lying in supine/prone positions, etc. They deduced that the human's segmental reflex is not rigid and inflexible. In other words, the irritability capacitance of the motor neurons is under influence of the supra-segmental areas and is changeable during different conditions [17]. In brief, the stretch reflex plays an adaptable role in different environments [13]. Using skin conducting test and some questionnaires Bolmont *et al*. [4] and Sibley *et al*. [12] reported that standing on a height stool could increase anxiety and simulate a threatening condition. It is proposed that any muscle activation in this situation will facilitate the main wave (M wave) production in EMG via muscle activation and hence postponed the H-reflex latency. The results of the current study also confirmed this non-significant increased latency of the H-reflex. The central nervous system (CNS) selects different options and modulates reflex activities, of which is changing in alpha (α) motor neurons' irritability. The level of alpha (α) motor neurons' irritability plays a key role in producing the amplitude of the H-reflex. Sibley *et al.* [12] proved that any changes in reflex are not a simple outcome of alpha (α) motor neurons' irritability. Some research showed a weak correlation between the EMG of the Soleus muscle and the amplitude of the H-reflex during standing position. It seems that the magnitude of the amplitude of the H-reflex is not influenced by the reciprocal inhibition, as Sibley *et al*. [12] showed no significant electromyographic changes in the tibialis anterior muscle. The pre-synaptic inhibitory role in modulation of the H-reflex during standing and the inhibitory role of the pre-synaptic organs located in higher cortical central of spinal reflexes during functional adjustment of the H-reflex during walking has already been investigated [12]. The same pre-synaptic inhibitory inputs may be sent caudally through cortical descending fibers to control postures during hard postural control situations [10]. The H-reflex adjustment could be related to the changes in irritability of the Gama motor neurons and vestibular inputs [12]. The findings of the current study regarding the effects of postural anxiety on modulation of the H-reflex of the Soleus muscle are in agreement with the findings about adjustment of the body's postural sway [3, 18]. Their findings confirm the theory of the flexibility of the H-reflex of the body when somebody is in threatening condition [17]. Based up on the previous study, the correlation between the anxiety and balance disturbances is probably due to the function of the central neural pathways in controlling vestibular processing, autonomic function, emotional responses and anxiety. The anatomical pathways between the vestibular and parabrachial neuclei is a direct connection between the vestibular and neural systems during anxiety and emotional demonstrations. Balaban and Thaye [19] reported that the physiological expressions following fear and anxiety are produced in parabrachial neuclei [19]. It seems that the main cause of modulation of the spinal reflexes during threatening conditions is the dominancy of the supra spinal centers to keep the postures through pre-synaptic inhibition of the mono-synaptic terminal of the afferent fibers in junction with the Soleus's motor neuron. The reduced H-reflex amplitude during standing relative to the prone lying position is resulted from the pre-synaptic tonic inhibition of the Ia fibers. That is, the inhibitory inter-neuron pathways on Ia terminals is activated to keep the upright posture. Other H-reflex inhibitors of the Soleus muscle could be changes of the peripheral inputs of the leg muscles or ankle joint. Any changes of the peripheral inputs results in inhibitory effects. It could be concluded that due to the different requirements, the motor control of the reflex adjustment and segmental descending inputs should be different at different conditions. One of the main reasons for reduced intensity needed to record the H-reflex in standing relative to the prone lying position might be due to the stretching of the skin and muscle in this position, which results in more sensitivity and reduced stimulatory threshold in standing position, particularly in anxiety condition. The vestibular role in H-reflex modulation was not investigated in this study; however, it has already been proved that visual effects are important in both static and dynamic situations [19]. In previous studies, the correlation between the height and visual feedback to re-adjustment of postural sway were evaluated. It was revealed that only in presence of visual feedback, the increased height will result in more controlling of the COM and COP [18]. Sibley *et al*. [12] showed the important role of visual feedback in postural perception and postural anxiety (Standing on a high stool). When anxiety increases, visual feedback plays a major role in adjustment of the neural mechanisms. e.g. reduced spinal reflex irritability in the presence of visual feedbacks to control human posture. When recording the H-reflex in standing position at the edge of the height, popliteal stimulation could itself make postural instability via knee flexion occurs following the stimulation. This indeed could increase anxiety while standing on the edge of a height. In the present study, none of the subjects showed any sense of falling when stood at the center or the edge of the stool. This shows that this mono-synaptic reflex plays a minor role in controlling body posture during comfortable standing. This also shows that postural control is resulted from a complex counter balance between the musculoskeletal and neural systems. Since all of the subjects participated in current study had a lower anxiety score, in agreement with some previous research, old age and anxiety discomforts could affect on the postural control in normal and threatening conditions [21-22]. Therefore, it is possible to see different results when this study is repeated in subjects with high anxiety score.

The results of this study showed that postural anxiety and/or fear of falling from a one-meter height stool may produce some changes on the effects of the H-reflex firing pattern. The results of these inputs on the alpha (α) motor neurons of the leg muscles should tightly be monitored by the supra-segmental centers to have a good postural control in threatening conditions.

It seems that the main cause of modulation of spinal reflexes in threatening condition is the supra-segment control to maintain the correct posture via pre-synaptic inhibition of the mono-synaptic afferents' terminals in junction of the Soleus' motor neuron.

ACKNOWLEDGEMENT

The researchers of the current study would like to thank the physiotherapy research center of the University of ShahidBeheshti and all the students participated in this study.

REFERENCES

1. Seligman, M. and D. Ruznahan, 2002. Asib shenasi ravani, Translated by Y. Mohamadi, Tehran: NashreSavalan, pp: 300-320 [in Persian].
2. Maki, B.E., P.J. Holliday and A.K. Topper, 1991. Fear of falling and postural performance in elderly. Journal of Gerontology Medical Sciences, 46: 123-131.
3. Adkin, A.L., J.S. Frank, M.G. Carpenter and G.W. Peysar, 2000. Postural control is scaled to level of postural threat. Gait and posture, 12: 87-93.
4. Bolmont, B., P. Gangloff, A. Vouriot and P.P. Perrin, 2002. Mood states and anxiety influence abilities to maintain balance control in healthy human subjects. Neuroscience Letters, 9: 96-100.
5. Wada, M., N. Sunagam and M. Nagi, 2001. Anxiety affects the postural sway of the antro-posterior axis in college students. Neuroscience letters, 302: 157-159.
6. Yardley, L. and H. Smith, 2002. A prospective study of the relationship between feared consequences of falling and avoidance of activity in community-living older people. Gerontologist, 42: 17-23.
7. Brown, L.A. and J.S. Frank, 1997. Postural compensation to the potential consequences of instability: Kinematics. Gait Posture, 6: 89-97.
8. Steven, J.A., 2005. Falls among older-risk factors and prevention strategies; Journal of Safety Research, 36: 409-411.
9. Capaday, C. and R.B. Stein, 1986. Amplitude modulation of the soleus H-reflex in the human during walking and standing. Journal of Neuroscience, 6: 1308-1313.
10. Llewellyn, M., J.F. Yang and A. Prochazka, 1990. Human H-reflexes are smaller in difficult beam walking than in normal treadmill walking. Experimental Brain Research, 83: 22-28.
11. Mahram, B., 1998. Validity and reliability of Spielberger anxiety test in Mashhad city. Tehran: Allame Tabatabayee University. Faculty of Psychology [in Persian].
12. Sibley, K., M.G. Carpenter, G.C. Perry and S.J. Frank, 2006. Effect of postural anxiety on the Soleus H-reflex, Human movement science, 26: 104-112.
13. Sarmadi, A.R., S.M.P. Firoozabadi, G. Torkaman and Y. Fathollahi, 2004. Assessing information of Soleous and gastrocnemius motor unit H-Reflex response to paired stimulation. Electromyogr Clin Neurophysiol., 44: 401-408.
14. Koceja, D.M., C.A. Marku and M.H. Trimble, 1995. Postural modulation of the Soleus H reflex in young and old subjects. Electroencephalography and Clinical Neurophysiology, 97: 387-393.
15. Zahedi, A.R., 2003. An investigation into the effects of the 1st. 2nd and 3rd McKenzie low back Position on H-reflex change in patients with unilateral S1 radiculopathy. Tehran: Tehran university of Medical Science, MSc. Thesis, Department of Physiotherapy; [in Persian].
16. Mcllory, W.E., D.C. Bishop, W.R. Staines, A.J. Nelson, B.E. Maki and J.D. Brook, 2003. modulation of afferent inflow during the control of balancing tasks using the lower limbs. Brain Research, 961: 73-80.
17. Bove, M., C. Trompetto, G. Abbruzzese and M. Schieppati, 2006. The posture-related interaction between Ia-afferent and descending input on the spinal reflex excitability in humans, Neuroscience Letters, 397: 301-306.
18. Carpenter, M.G., J.S. Frank and G.W. Peysar, 2001. The influence of postural threat on the controlof upright stance. Experimental Brain Research, 138: 210-218.

19. Balaban, C.D. and J.F. Thaye, 2001. Neurological basis for balance-anxiety links. Anxiety Disord, 15: 53-79.
20. Carpenter, M.G., J.S. Frank and C.P. Silcher, 1999. surface height effects on postural control, A hypothesis for a stiffness strategy for stance. Journal of Vestibular Research, pp: 277-286.
21. Shaw, J.A., L.E. Stefanyk, J.S. Frank, A.M.S. Jog and L. Adkin, 2012. Effects of age and pathology on stance modifications in response to increased postural threat. Gait and Posture, 35: 658-661.
22. Levitan, M.N., J.A. Crippa, L.M. Bruno, D.L. Pastore, R.C. Freire, K.C. Arrais *et al*., 2012. Postural balance in patients with social anxiety disorder. Braz. J. Med. Biol. Res., 45: 38-42.