THE REGULATION OF LEG STIFFNESS AND EMG ACTIVITIES ON PERSON WITH VISUAL IMPAIRED DURING STEP-DOWN WALKING

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The purpose of present study was to evaluate leg muscular regulation and neuromuscular activation by investigating the stiffness and EMG amplitude of normal vision students and visually impaired students. 10 normal vision (age: 24.3±20 years; height: 171.5±4.6cm; mass: 65.9±8.0kg) and 10 visually impaired students (age: 23.2±2.4 years; height: 163.4±9.6cm; mass: 62.8±15.0kg) were served as subjects. AMTI force platform (1200 Hz), Peak Performance motion analysis system (60Hz) and Biovision EMG system were used synchronously to record the ground reaction force, the kinematic parameters and EMG signals of lower extremity during the subjects stepped down from height 20, 30 and 40cm. The results revealed that the regulation of neuromuscular system of the impaired is less efficient compared to the normal one because of lower muscle stiffness and EMG activity.

KEY WORDS: visually impaired students, muscle stiffness, EMG.

INTRODUCTION: The vision ability plays a very important role in human daily life. Vision, proprioception, and vestibular system provide the main source of information about the position, motion of the head and body in space, and on human body balance. When the balance is damaged and results in the body falling, the first motor response switched is the regulation of muscular stiffness. This reaction time period for the motor nerve system is at 50 to 200 ms. In other words, the neuromuscular system must adjust body stiffness in order to accomplish the response of stumbles (Houk, 1979). In this process, vision plays an important role. To distinguish the stiffness regulation ability by vision, we compare the stiffness induced from the stepping down from different heights between normal vision students and visually impaired students.

There are at least two pre-requirements when the lower body experiences muscular regulation from landing: 1) Muscles generate appropriate stiffness according to the feedback of eyesight and central nervous command, 2) Due to the stretch reflex, the muscles will generate better activation during eccentric contraction. The stretch reflex also affects the EMG activity, so we also examine EMG activity to understand the neuromuscular activation.

The higher the riser is, the higher the activation of pre-contact phase that occurs before landing is. According to Schidtbleicher, D and Gollhofer, A. (1982), on the movements of drop jump, the neuromuscular system can detect the stretch intensity and jump altitude through the intuition system, and signs of pre-activation for muscular is controlled by the visions. Without the help of vision, we want to know if the pre-activation of vision impaired one is different from the normal one.

Therefore, our purpose is to analyze variance on the lower body muscular stiffness and EMG activity of contact and pre-contact between visually impaired students and normal vision students on the process of movement for walking down stairs to identify the effects of eyesight for neuromuscular activation control and muscular stiffness adjustment.

METHODS: Subjects were 10 normal vision students(age: 24.3±20 years; height: 171.5±4.6cm; mass: 65.9±8.0kg) and 10 visually impaired students (age: 23.2±2.4 years; height: 163.4±9.6cm; mass: 62.8±15.0kg) were asked to perform the downward stepping from different heights:20, 30and 40 cm. AMTI force platform (sample rate: 1200Hz), Biovision system and Peak Performance high-speed camera (60 Hz) were used synchronously to record the ground reaction force, EMG signals and the video image of the movements. Leg muscular stiffness was defined in present study as: i) the ratio of maximal ground reaction force (Fmax) to the leg displacement (Xmax) during downward stepping (Fmax/Xmax). After collecting the data, the SPSS software was adopted to calculate the values of the parameters and t-test was used to test the difference between the normal vision students and visually impaired students.

The significance level of tests was set up a= 0.05.

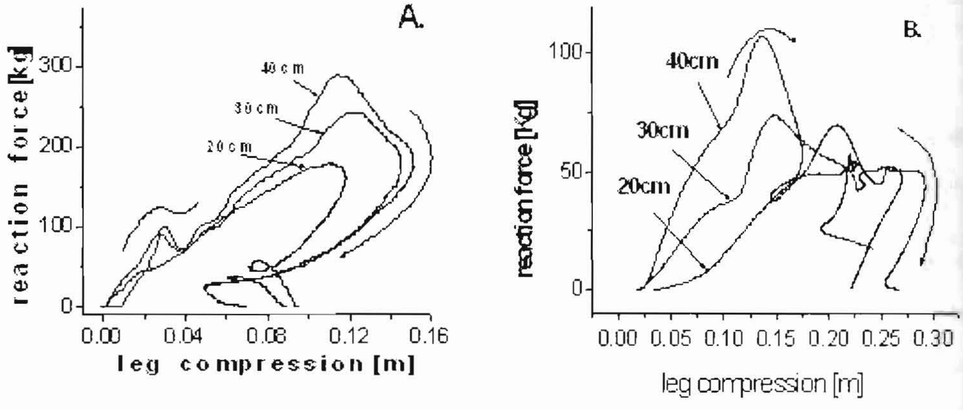

Figure 1: The relationship curves of Ground Reaction Force and Leg Displacement during downward stepping from different normal vision students (A) and visually impaired students (B).

RESULT AND DISCUSSION: The comparison of stiffness between normal vision students and visually impaired students: The results show that visually impaired students have less functional angular stiffness or leg stiffness compared to healthy vision students (Table 1) when stepping down from the different heights. This may be due to inefficient eyesight and the limitation of body movements, causing the strength of movement to decline and therefore the stiffness.

With the increase of landing height, the stiffness was increased significantly both for normal vision students and visually impaired students. The phenomenon of larger stiffness induced by higher riser may be that the intensity which was emphasized by the velocity under the same mass, because the higher the riser altitude is, the falling velocity is faster and the intensity is heavier when touching the ground.

Table 1 Stiffness compared between normal vision students and visually impaired students among three different altitudes.

Group	Altitude (cm)	Functional Angular Stiffness* (cm/deg)	Leg Stiffness* (kg/m)
	20	6.3±4.0	431.6±187.5
vision	30	5.6±3.9	475.5±147.2
impaired	40	7.2±7.3	551.5±172.1
	20	9.3±4.6	1764.7±975.2
normal	30	10.7±3.3	2084.3±327.2
vision	40	13.0±3.7	2381.1±520.5

*Significant difference between groups $p<0.05$

The comparison of EMG activity between normal vision students and visually impaired students: After the standardized EMG were treated, according to table 2, the result shows that the IEMG for visually impaired students is less compared to the normal vision students before touchdown on two muscular groups. According to the research of Schidtbleicher and his colleagues (1982), signs of pre-activation for muscular is controlled by vision. The normal subjects received the feedback of outer information from the eyesight, so the neuromuscular is activated for preparing to step down from the different heights and the EMG activation is larger. On the contrary, the impaired subjects have no such preparation without the use of sight of stepping down, so no innervation is initialized and the EMG activity is lower.
As for the contact phase, the EMG amplitude induced by visually impaired students is smaller than that of normal vision students. The results implied that the visually impaired students have less ability to distinguish and detect their environment under the condition of no feedback from the eyesight. Under such circumstance, the nerve muscular system will generate a sign of inhibition of stretch reflex and therefore myoelectric activity clearly declined after touchdown.

Table 2 IEMG before Touchdown from Various Altitudes.

Group	Altitude (cm)	Rectus femoris (%)	Biceps femoris (%)	Tibialis anterior (%)	Gastrocnemius (%)
	20	2.5±2.7	2.8±3.1	3.1±1.8	1.6±1.0
vision	30	3.0±0.2	2.5±2.0	3.0±1.8	2.6±1.0
impaired	40	3.4±3.4	2.5±1.5	3.3±1.4	3.0±1.7
	20	2.6±3.0 *	7.3±6.5	4.4±8.8	2.8±2.2
normal	30	2.8±3.1 *	6.0±5.1	4.7±10.1	3.3±2.1
vision	40	4.1±5.4 *	5.6±6.3	5.6±11.2	5.1±2.4

*Signs of variance in altitude *Sight of variation in groups $p<0.05$

CONCLUSION: After treating the data, the results were obtained. The result are i) The stiffness of the functional angular and leg stiffness are more tense for normal vision students as compared to the visually impaired students. This phenomenon shows that the ability of stiffness regulation of the normal one is more efficient than that of impaired ones. ii) The myoelectric activities (EMG) of pre-contact or contact phase of visually impaired students were smaller than those of normal ones. This may be due to the inhibition produced and caused less activation. According to the results, we concluded the following. On the movement of walking down stairs, visually impaired students will employ different movement techniques from those of the normal vision students. So the regulation of neuromuscular system of the impaired is less efficient compared to the normal one because of softer stiffness and lower EMG activity.

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