Original Article

The effect of finger tip contact on the electromyography activity of ankle muscles

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ABSTRACT

Objective: To investigate the effect of the light touch, vision and dual task interference on the surface electromyography (sEMG) activity of ankle muscles.

Methodology: Thirty right handed healthy persons stood in an upright and semi-tandem position and pressed the sensor plate in a rate less than 50 gr. sEMG activity was measured in three muscles (Tibialis Anterior, Proneus Longuse and Soleuse on both lower limbs by Biometrics sEMG). Four positions were considered in semi-tandem standing i.e.: 1) No Touch, No Counting; 2) No Touch, Counting; 3) Light Touch, No Counting; 4) Light Touch, Counting. Each of the above positions was tested in two positions by means of Eyes Open, Eyes Closed.

Results: sEMG activity of the ankle muscles was lower in the light touch contact (LTC) ($P<0.05$), but higher during no-counting than counting ($P<0.05$).

Conclusions: LTC and the concentration on counting, stimulate the Central Nervous System for activating the postural muscles of hip and trunk. So the amount of imposed force on ankle muscles will be reduced.

KEY WORDS: Skin receptors, Balance, Superficial electromyography, Dual task.

Pak J Med Sci October - December 2010 Vol. 26 No. 4 864-866

How to cite this article:

Bazrafshan AR, Okhovatian F, Naeemi S, Ghorbani M. The effect of finger tip contact on the electromyography activity of ankle muscles. Pak J Med Sci 2010;26(4):864-866

INTRODUCTION

Human body is a high construction that its balance is maintained on a relatively small base of support. Balance control is a complex of relationships between neural system with contractive and non contractive systems that have connection with each other by peripheral and feedback systems.[1]

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* Received for Publication: February 12, 2010
* Revision Received: July 17, 2010
* Second Revision Received: July 21, 2010
* Final Revision Accepted: July 22, 2010

The previous researchers[2] explained that light touch contact of index finger is effective for balance control even in the absence of vision. The study of Jame et al;[3] supported the effectiveness of light touch contact on balance control and demonstrated the role of tactile sense is more effective than vision sense to gain static balance in bilateral vestibular deficiency patients.

In addition, Baccini et al;[4] demonstrated light touch contact as an effective factor in hard conditions. Furthermore, it is very useful while the base of support moves in direction of body sway or standing on a soft matter. According to Lackner et al;[5] contact of finger with stable things, inhibits abnormal sensory and motor inputs related to lower limbs. So body sways resulted in fatigue of leg muscles can be compensated.

Baccini et al; focused his study on blind and sighted people. He considered the role of tactile sense on balance control. One of his results is the theory which defines the cane as a consciousness aid than a mechanical one. Therefore, with regard to the previous studies, the purpose of this paper was to investigate

the effect of the light touch, vision and dual task interference on the surface electromyography (sEMG) activity of ankle muscles.

METHODOLOGY

A) Participants: This study was performed on volunteers who were referred to research center of rehabilitation College of Shaheed Beheshti University of Medical Sciences and Bou-Ali Hospital under supervision of Azad University. After clinical assessment and confirming the good health of participants, final cases were selected by simple random sampling method. Thirty right handed ones (men & women), not sporting, in the range of 20-40 years old with no neural and musculoskeletal disorder and history of surgery were examined.

Patients with anatomical and biomechanical disorders such as Genuvaruse, Genuvalguse, Scoliosis as well as those with infectious disease of internal ear, vision disorders, skin diseases and drug allergies were excluded. Also all of them were in normal range of Body Mass Index (20-25 Kg/m^2).[6]

B) Methodology: All the patients were educated about the processes before the examination to prevent any anxiety during the test time. To have the exact records, all the bases of sEMG recording, were considered.[7] Biometrics Data Log was used for sEMG recording which had eight channels. One of them was ground electrode and six of them connected to Tibialis Anterior, Proneus Longus and soleus in both lower limbs. Placement of electrodes was according to SENIAM.[8]

This study was performed in four positions when the cases standing in Semi-Tandem position:

1. Non Touch – No counting
2. Light Touch – No Counting
3. Non Touch – Counting
4. Light Touch – Counting

Each of the positions was examined with eyes open and eyes closed. A high sensitive sensor was put at the right side of participants in level of greater trochanter of femur. They should have light touch contact (LTC) on the sensor by their right index up to 50 gr, because of exciting only neural system whereas biomechanical mechanisms. They wanted to stand upright in defined position for 25 seconds. To maintain the head and neck in upright position, we put a sign forward to them in direction of their vision.

At first, there was not any contact between index finger and sensor. Participants were asked to stand in Semi –Tandem position for each condition of test about 25 seconds. Then sEMG recording was performed with open eyes and after one minutes resting, it was done with closed eyes.

Second phase was done in touch contact in two conditions: open and closed eyes. Third phase was examined when non- touch and counting conditions with open and closed eyes. Finally we studied sEMG activities of both ankles muscles in light touch and counting conditions with open and closed eyes.

C) Data Analysis: Analysis of data was done by paired sample t-test through SPSS Ver. 17 software program. Considered variable was RMS (Root Mean Square) of sEMG activity in studied muscles. 95% confidence interval was calculated when data were sufficient.

RESULTS

Investigating the rate of sEMG activity of ankle muscles while Non Touch Closed Eyes (NC) and Touch Closed Eyes (TC): In TC, skin receptors of index, has a major role in reducing the rate of sEMG activity than NC. So in the both legs, this rate in TC was less than NC. ($P<0.05$) (Table-I).

Comparing each paired positions by considering Counting and No Counting conditions:

To investigate the role of counting on the rate of sEMG activity of right ankle muscles by considering light touch and vision sense, we compared each paired positions.(Table-II) In all the conditions to record the RMS of sEMG activity, the rate of counting was lower than no-counting except in non- touch closed eyes condition. But only differences between Touch- closed eyes (TC) and Counting Touch closed eyes was implicated. ($p< 0.05$) (Table-II).

In the left leg, RMS of sEMG activity in all conditions of no- counting was lower than counting but the results were not implicated ($P>0.05$).

Table-I: The role of touch on RMS.

		Mean	*N*	*SD*	*Stan. Error*
Pair 1	RLTC	0.027	30	0.015	0.003
	RLNC	0.039	30	0.016	0.003
		Mean	*N*	*SD*	*Stan. Error*
Pair 1	LLNC	0.023	30	0.009	0.002
	LLTC	0.016	30	0.008	0.001

* Right Leg Touch Closed eyes (RLTC) - Right Leg Non Touch Closed eyes (RLNC),
* Left Leg Touch Closed eyes (LLTC) - Left Leg Touch Non Touch Closed eyes (LLNC).

In TC, skin receptors of index, has a major role in reducing the rate of sEMG activity than NC. So in the both legs, this rate in TC was less than NC. ($P<0.05$).

Table-II: Relationship between counting and non-counting on RMS.

		Mean	*N*	*SD*	*Stand. Error*
Pair 1	RLCNO	0.023	30	0.008	0.001
	RLNO	0.025	30	0.011	0.002
Pair 2	RLCNC	0.040	30	0.035	0.006
	RLNC	0.039	30	0.016	0.003
Pair 3	RLCTO	0.019	30	0.009	0.002
	RLTO	0.023	30	0.022	0.004
Pair 4	RLCTC	0.021	30	0.010	0.002
	RLTC	0.027	30	0.015	0.003

* Right Leg Non-Touch Open eyes (RLNO) - Right Leg Non-Touch Closed eyes (RLNC),
* Right Leg Touch Open eyes (RLTO) - Right Leg Touch Closed eyes (RLTC).
In all of the conditions, RMS of sEMG activity, counting was lower than no- counting except in non- touch closed eyes condition. But only differences between Touch-closed eyes (TC) and Counting Touch closed eyes was implicated. ($P < 0.05$)

DISCUSSION

The results of this study have clinical implications for understanding how patients may benefit from (skin sensory inputs of hand) finger contact to compensate postural instability. Only few studies have investigated this issue. Some researchers obtained light touch contact as a very effective factor in balance control even if vision was absenet.[2,3,9,10] In addition, James et al[3] focused their studies on bilateral vestibular deficiency patients. They discussed about the role of light touch contact in their patients while closing their eyes. They concluded that light touch contact is more effective than vision in static balance controlling.[3]

In 2006, Baccini et al; declared that non touch can increase body sway in older people especially during vision absence. But body sway would be decreased while light touch contact and closed eyes condition. This is because of excitation the postural mechanisms related to sensory inputs from finger tip. Therefore it seems that light touch contact can compensate vision deficiency.[9]

The present findings confirm the RMS in Light Touch Closed eyes (TC) is lower than Non Touch Closed eyes (NC) in both legs. During perturbation, it seems that postural muscles of hip and trunk can be activated and subsequently tolerates some forces imposed to ankle muscles. So the amount of imposed force on leg muscles will be reduced. Also sensory inputs from the tip of index finger can excite the complicated sensory feedback mechanisms. So that postural muscles of hip and trunk will act simultaneously. This kind of activation may reduce the imposed load on ankle postural muscles.

On the other hand, to determine the role of counting in perturbation of balance and increasing the rate of sEMG activity in leg postural muscles, all similar positions except in counting, were compared with each other. In all positions, RMS was higher during no-counting than counting. But in Non Touch Closed eyes (NC), RMS was lower than Counting Non Touch Closed eyes (CNC). So sEMG activity reduced in counting conditions but the differences were not implicated except Light Touch Closed eyes (TC) and Counting Touch Closed eyes (CTC). This implication suggests that concentration on counting drives Central Nervous System to excite hip and trunk postural muscles activity and finally the improvement of body balance control can be achieved.

CONCLUSION

On the basis of our findings, it seems that light touch contact, can stimulate the Central Nervous System for activating the postural muscles of hip and trunk. So the amount of imposed force on ankle muscles will be reduced. In addition, our results suggest that concentration on counting drives Central Nervous System to excite hip and trunk postural muscles activity and the improvement of body balance control can be achieved. In view of the counting and its effects on the rate of sEMG, we suggest performing such studies in large number of cases, Moreover future studies should have focus on two groups i.e., men and women and examine the rate of sEMG activity in other postural muscles.

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