International Journal of Life science & Pharma Research

THE EVALUATION OF THE LIFTING SPEED BY SQUAT METHOD ON TRUNK MUSCLES ACTIVITY

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ABSTRACT

the lifting of the loads is one of the risk factors for occupational back pain and the study of trunk muscles as the main and involved muscles in lifting is important from viewpoint of biomechanics and ergonomics. This study aimed to investigate the effect of lifting speed on the activity of lumbar and abdominal muscles during lifting by Squat method. the number of 27 healthy men was studied; so that, there was no medical history of low back pain and musculoskeletal disorders in these men. The data were collected from the left and right Erector spinae and the Multifidus muscles as well as the left and right Rectus and external oblique of the participants using electromyography (EMG); and after filtering and normalization of data to MVC, the signal processing was performed using MATLAB software. The statistical analysis was carried out using SPSS 16. the statistical analysis showed that the trunk muscles activities at high, medium and low speeds were significant ($p<0.05$). It also observed that the load weight which is lifting by a person has a direct effect on the activity of trunk muscles. it can be concluded that the lifting speed, in addition to the weight of load, can be considered as a risk factor for low back pain.

Keywords: ***Lifting the load, Squat, Electromyography, Trunk muscles, Speed***

INTRODUCTION

The lifting is the most important risk factors for low back pain. As it has been previously reported, the prevalence of back pain during the human life is about 60 to 80 percent[1]. The lifting of the load is considered as the reason for low back pain and is the subject of many studies[2-5] For instance, the lifting technique in terms of biomechanical aspects is one of attracting subject for researchers[6]. One of the studies, which conducted on the lifting and manual carrying of the loads in different aspects, is the NIOSH equation of the load. In fact, this equation evaluates the ergonomics aspects of lifting and is one of the most useful and important method in this context[7]. In a study, the kinematic and kinetic variables of the lifting of the loads were investigated and the results showed that the bending moment increases with the speed and vice versa. In addition, it was found that the controlling system of body motion during the lifting is independent of the load weight changes, but it is dependant to motion speed changes[8]. Ghofrani and Tabatabaei[8] were conducted a study to evaluate the effect of lifting speed on the bending moment of the L5/S1 joint and on the muscle activity during their loading. In their study, the motion analysis and the force plates were used to obtain the kinematic and kinetic data of the motion. Two-dimensional kinematic model consists of 5 segments were used for modeling the motion in Sagittal plane. The motion was performed in three different speeds and with three different weights. The inverse dynamics was used to extract the bending moment on the joints L5/S1. Both Kinetic and kinematics parameters were studied. The results indicated that the bending moment increases with the speed and vice versa. It was also observed that the shape and curve pattern

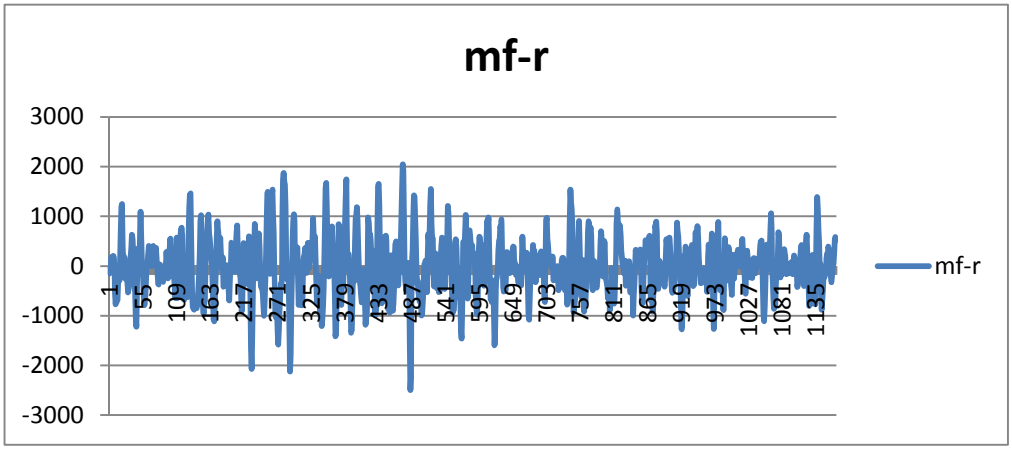
of the bending moment is changed by increasing the speed of the lifting; so that, the bending moment curve has greater turning points in low speeds compared to the bending moment curve in higher speeds and the number of turning points of the curve decreases by increasing the speed which it can be due to change in type of interaction between the extensor and flexor muscles in order to control the motion speed during the movement. It has also observed that increasing of the load weight has no significant effect on the change in the shape and the pattern of bending moment curve and it increases only the amount of desired bending moment. Furthermore, the results showed that the motion control system and the motion control strategy of the human body for the lifting was independent of motion of changes in lifted load but it is dependent on the motion speed. The lifting speed of the loads is an independent risk factor for low back pain[9-11]. It has also reported that it can affect on the electrical activity of the trunk muscles[12]. Previous studies show the importance of trunk muscles in lifting the loads. In this study, the effect of lifting speed on electrical activity of the lumbar and abdominal including erector spinae and multifidus muscles and external oblique and rectus abdominis in health individual is investigated.

MATERIAL AND METHODS

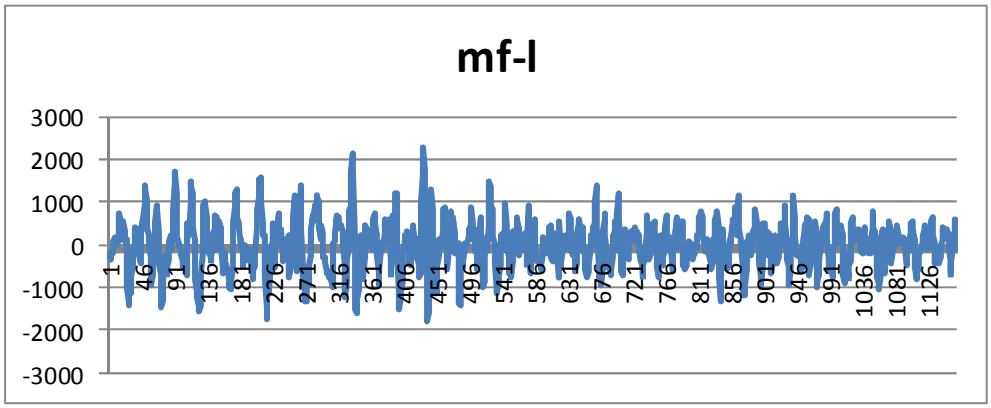
This cross-sectional study was conducted using the simple sampling among available people in the age range of 20-30 years. The number of 27 healthy men was studied; so that, there was no medical history of low back pain and musculoskeletal disorders in these men which it was diagnosed by the physician. The BMI were between 20 and 25. Participating in the trial or leaving it at any time was completely voluntary and with the consent of the individual. The ethics committee of Mazandaran University of Medical Sciences approved the conducting of this research. To record the muscle activity in the trunk muscles including erector spinae and multifidus muscles and external oblique and rectus abdominis, a biometrics 8-channel electromyography device was utilized. The skin was completely shaved by a sharp blade and was cleanedby cotton and alcohol. The location for the installation of the electrodes was determined based on the seniam standard[13]. It should be noted that all participants lifted the loads with the weight of 4, 8, 12 Kg and with speeds of low, average and fast and the electromyography tests were simultaneously taken from the lumbar and abdominal muscles. After eliminating the noise and filtering the signal using MATLAB software, the electrical activity of muscles was normalized with respect to MVC. Finally, the Spss 16 were utilized for statistical analyses and to achieve the statistical output.

RESULT

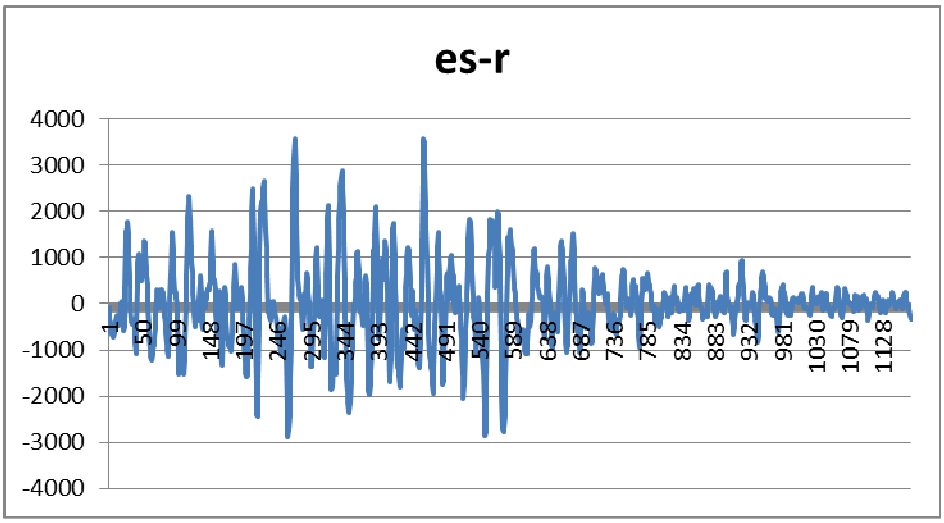
The signal processing of the raw data were performed using MATLAB software. The signal related to the raw data signal obtained from each muscle is shown in following Figures:



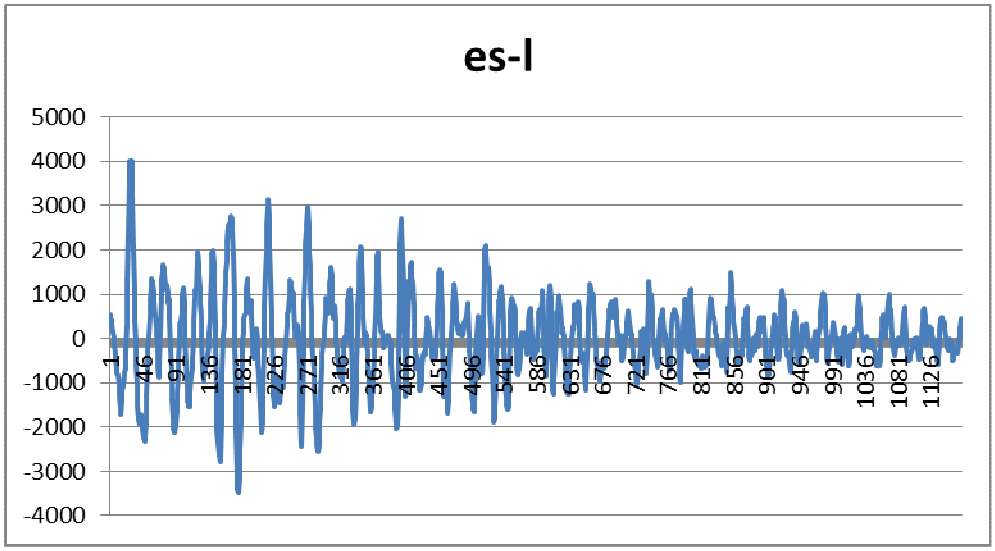
Raw data related to right multifidus muscle EMG



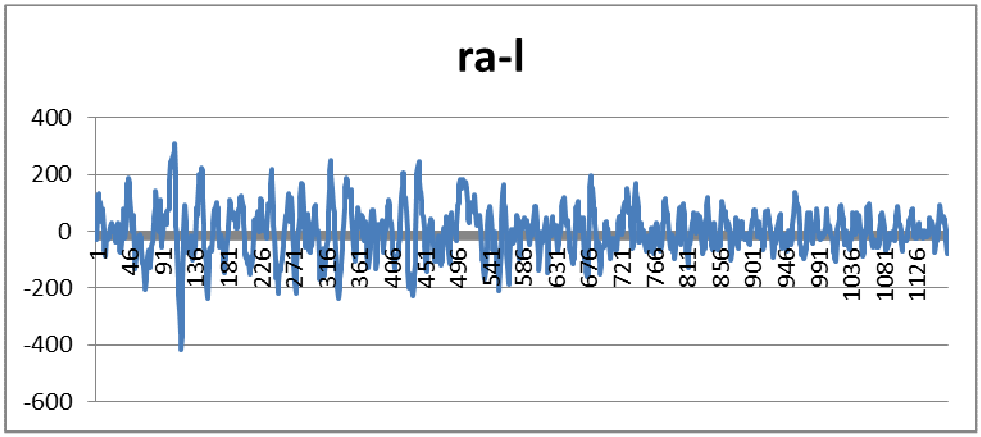
Raw data related to left multifidus muscle EMG



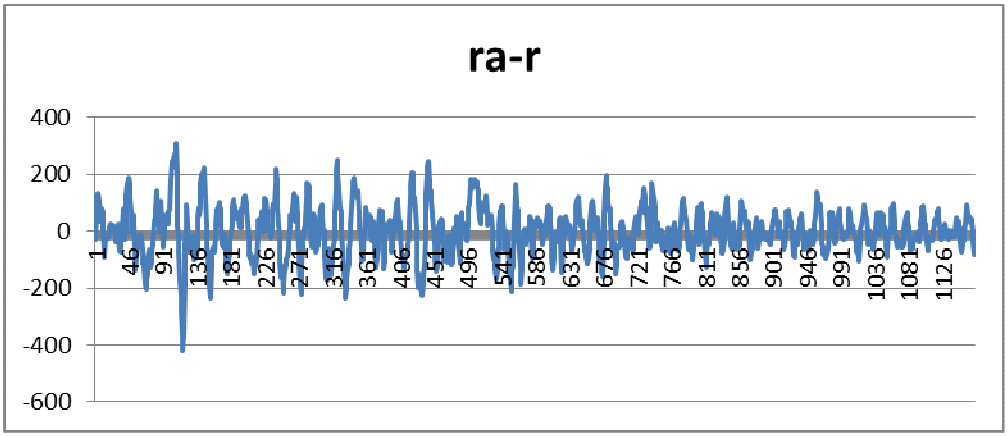
Raw data related to right erector spinae muscles EMG



Raw data related to left erector spinae muscles EMG



The EMG raw data of left rectus muscle



The EMG raw data of right rectus muscle

The results of statistical analysis in SPSS software is shown in this section. It should be noted that the analytical statistics load weight as covariate, in addition to the results of descriptive statistics weight were considered:

Continuous Variable Information

	Mean	Std. Deviation
Dependent Variable: mean	.153603	.1135578

As can be observed, the variable of load weight has a direct effect on the output of our study

Parameter Estimates

Parameter	B
(Intercept)	.108
Speed: Slow	.022
Speed: Medium	.010
Speed: Fast	0[a]
Weight	.004

Dependent Variable: mean
Model: (Intercept), speed, weight
a. Set to zero because this parameter is redundant

DISCUSSION

As it is clear from the results of the raw data of the EMG signals, the results cannot be interpreted without processing and, in fact, the EMG signals like other biological signals need to signal processing for interpretation because these signals are associated with many noise and turbulence and they need to signal processing, according to requirements of the study, to achieve a certain result. In this study, the signal processing was carried out using the MATLAB software to study the intended variable (mean). Statistical analysis of this variable showed that both speed and load

weight can effect on the mean; on other hand, there is significant relationship between speed and mean as well as between the load and the mean. The paired t-test showed the significant relationship in different speed ($P<0.05$). Weight of load which is lifted by a person was considered as a covariate. Also, about parameter estimation, the beta value s for speed and weight were significant. Kasey et al[14] has investigated the effect of lifting speed of the load on the pressure force on vertebral column. They have found the direct relationship between the increasing of the lifting speed and increasing the pressure force on vertebral column. The comparison of the results of present study with the results of their study can be found that increasing the compressive force on vertebral column and the lumbar and abdominal muscles activity in one direction and lifting speed has a direct relationship with both of them. The studies conducted by Dolan et al[12] and Ghofrani and tabatabaei[8] revealed that the bending moment in lumbar region in joint of L5/S1 increases by increasing the lifting speed. In the lumbar and abdominal muscles activity around the mentioned joint has also studied in these researches. The results of our study have also showed that muscle activity has a direct relationship with increasing speed. In fact, it can be found that increasing the bending moment in the joint L5/S1, which is related to the skeleton and muscles, is associated with increasing the muscles activity surrounding that. On other hand, the tolerance of L5/S1 joint and the surrounding muscles with increases by increasing the speed to prevent the accordance of injury.

CONCLUSION

Considering the direct effects of the lifting speed on the lumbar and abdominal muscles activity, it can be concluded that the factor of the lifting speed can be a risk factor for low back pain. Therefore, it is suggested that the researchers give more attention, according to a prospective study, towards operating speed lifting and back pain in population of workers.

ACKNOWLEDGEMENT

The authors are sincerely grateful from the Deputy of Research and Technological of Mazandaran University of Medical Sciences which supported the research financially and from Head of Biomechanics Laboratory of Ergonomics Group of the University of Social Welfare and Rehabilitation and all of those who helped us in this study.

REFERENCES

1 Smith D, Leggat P. Musculoskeletal disorders in nursing. Australian Nursing Journal: ANJ, The. 2003;11(1):19.

.2 Gagnon M. Box tilt and knee motions in manual lifting: two differential factors in expert and novice workers. Clinical Biomechanics. 1997;128.-419:(8-7)2

.3 Gagnon M, Plamondon A, Gravel D. Pivoting with the Load: An Alternative for Protecting the Back in Asymmetrical Lifting. Spine. 1993;18(11):1515-24.

.4 Potvin J, Norman R, McGill S. Reduction in anterior shear forces on the L4L5 disc by the lumbar musculature. Clinical Biomechanics. 1991;6(2):88-96.

.5 Toussaint HM, Van Baar CE, Van Langen PP, De Looze MP, Van Dieen JH. Coordination of the leg muscles in backlift and leglift. Journal of Biomechanics. 1992;25(11):1279-89.

.6 van Dieën JH, Hoozemans MJ, Toussaint HM. Stoop or squat: a review of biomechanical studies on lifting technique. Clinical Biomechanics. 1999;14(10):685-96.

.7 Waters TR, Putz-Anderson V, Garg A, Safety NIfO, Health. Applications manual for the revised NIOSH lifting equation: Citeseer; 1994.

.8 Maab MG, Tabatabaei F, editors. Investigating the Effect of Speed on the Moment Acting on the Spine and Muscles Behavior during Loading by Utilizing Motion Analysis System. 6th World Congress of Biomechanics (WCB 2010) August 1 2010 ,6-Singapore; 2010: Springer.

.9 Houtman IL, Bongers PM, Smulders PG, Kompier MA. Psychosocial stressors at work and musculoskeletal problems. Scandinavian journal of work, environment & health. 1994:139-45.

.10 Marras W, Mirka G. A comprehensive evaluation of trunk response to asymmetric trunk motion. Spine. 1992;17(3):318-26.

.11 Zhang X, Xiong J, Bishop AM. Effects of load and speed on lumbar vertebral kinematics during lifting motions. Human Factors: The Journal of the Human Factors and Ergonomics Society. 2003;45(2):296-306.

.12 Dolan P, Adams M. The relationship between EMG activity and extensor moment generation in the erector spinae muscles during bending and lifting activities. Journal of biomechanics. 1993;26(4):513-22.

.13 SENIAM(Surface Electo MyoGraphy for the Non-Invasive Assessment of Muscles) 2005 [Recommendation for sensor locations on individual muscles]. Available from: http://seniam.org/.

.14 Greenland KO, Merryweather AS, Bloswick DS. The effect of lifting speed on cumulative and peak biomechanical loading for symmetric lifting tasks. Safety and health at work. 2013;4(2):105-10.