A Study on the effect of musculoskeletal disorder in Laundry shop of south west India

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Abstract—**A muscle fatigue is the main concern of the efficiency and productivity of any work. Even though the employer is concerned about the physical wellness of the employee, the workdone counts. Thus the muscle fatigue gains significance. When a limb is continuously used in same pattern, fatigue is developed. The muscle fatigue occurring during the laundry shop of ironing process at five different heights has been measured here. Surface EMG is used to measure the muscle fatigue occurring in three different muscles in the body: Biceps brachi medial, Anterior Deltoid and External Oblique. It has been found that the muscle fatigue differs for different muscles at different locations.**

***Keywords*— Muscle fatigue, Mean Power Frequency, Standard Deviation, Wilcoxon Factor.**

1.Introduction

When a muscle is continuously used for a particular work, it gets fatigued. If the working pattern is same, it gets fatigued soon. In some areas where automation and robotics are still not efficient and economical human work plays a vital role. When such works are done repeatedly, muscle fatigue occurs.

Muscle fatigue is defined as “the point at which the muscle is no longer able to sustain the required force or provide the necessary work output level” (Moritani et al., 1993). Fatigue can also be defined as an unavoidable and negative consequence of physical activity, resulting in reduced performance and function (Kirkendall, 1990). It may be more appropriate to view fatigue as a safety mechanism, modulated by either central or peripheral input, preventing metabolic crisis and preserving the integrity of the muscle fiber (Sergeant, 1994), thus preventing the development of injury and acting as a method contributing to reduction in the intensity of activity (Noakes, 1998; Wagenmakers, 1992). The decrease in skeletal muscle power output can be imputed to the reductions in neural drive which is the main reason for the muscle fatigue due to prolonged exercise (Lepers et al., 1992). Hence, fatigue should be seen as a continuous process that transforms the functional state, with exhaustion being the level at which exercise is terminated.

In our work we concentrate on muscle fatigue during the ironing process, where lot of human work is needed. In a laundry, laundry shop is to be arranged in adjustable table at different heights. The muscle fatigue occurring in this kind of work is measured here surface EMG and discussed.

EMG is a biosignal recorded from the skeletal muscle activity in the body. It is used by clinicians for analysis of skeletal muscle activity. The surface EMG measures the muscle activity from the surface itself using sEMG electrodes. During static exercises (isometric contractions), many researchers have demonstrated the good reproducibility of neuromuscular indices such as: integrated EMG (iEMG), RMS, mean power frequency (MPF) of the EMG power spectrum and/or muscle fiber conduction velocity (Laplaud et al., 2005; Farina et al., 2004; Falla et al., 2002; Dedering et al., 2000). Amplitude of the EMG signal was often used to assess the muscle activity in patients with pain (Roy et al., 1990). In addition to EMG amplitude analysis, spectral analysis of the sEMG has been used widely to detect and quantify electrical manifestations of muscle fatigue (Knaflitz and Molinari, 2003). During a sustained muscle contraction, the power spectrum of sEMG is scaled towards lower frequencies. At this time, spectral scaling is the most reliable sign of localized muscle fatigue; and some researchers relied on it for studying the variations of excitability of muscle fatigue during sustained contractions. These sustained muscle contractions are externally associated with not being able to maintain a certain force, and lead to physiological fatigue, trmor or pain, localized in specific muscle. This is called muscle fatigue (Basmanjian and Deluca, 1985) associated with a compression of the power spectral density (PSD) of the sEMG towards lower frequency (Stulen and Deluca, 1981), and is measured by mean power frequency computed from the sEMG power spectral density. Muscle fatigue is associated with increased integrated electromyogram (iEMG) and decreased mean power frequency (MPF) of EMG for a given performance (Edwards, 1981).

The aim of this study was to determine the muscle activity and fatigue of the biceps brachi medial, anterior deltoid and external oblique of a human during arranging books in a cup-board for an age group of 21-23 years.

2.Materials and Methods

2.1 Selection of Subjects

A group of five healthy right hand dominant males with age 21-23 years, height 169-173 cm and body mass of 66-72kg. The subjects should not have any history of muscle diseases/injuries or bone fractures.

2.2 Experimental Protocol

The subjects are made to sit in a comfortable arm chair for avoiding muscle fatigue during the experiment.
The subjects are advised to keep their body at rest for 30 minutes to avoid errors in measurement.

2.3 Placement of Electrode

The surface EMG electrodes are placed in three muscle locations where the measurement is to be taken. They are, biceps brachi medial, anterior deltoid and external oblique. The three muscles where the sEMG activity is to be measured is shown in the fig 1.

2.4 Formula used

We use the wilcoxon signed rank test for the calculation of muscle fatigue here.

- Wilcoxon factor, W=Sum of all magnitudes of FFT obtained.
- MPF(difference)=MPF(before)-MPF(after).
- Standard Deviation,
$$\sigma = \sqrt{((x1-\mu)^2 + (x2-\mu)^2 + \cdots + (xn-\mu)^2)/n}$$

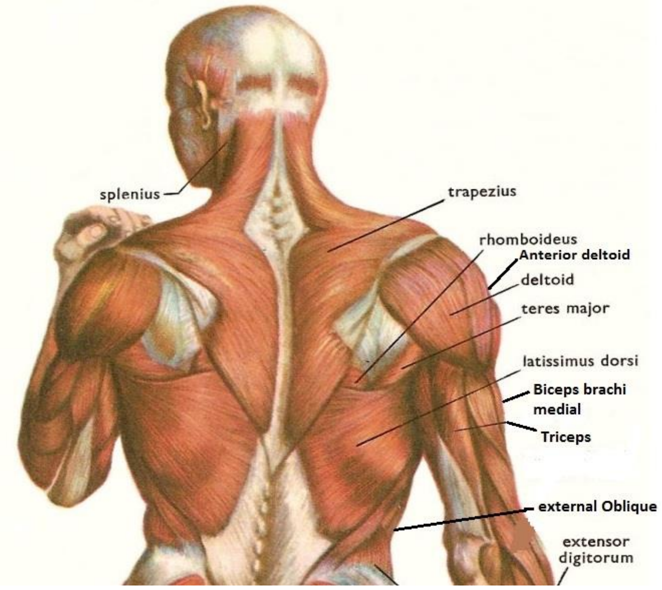

Fig 1 Muscles of a human body

3.Experiment

The experiment involves the movement of a iron box weight1.755 kg continuously from a height of 47 cm to five different heights using right arm and the readings are recorded.

The five different heights are,

a) 34cm from the ground level
b) 38 cm from the ground level
c) 40cm from the ground level
d) 42 cm from the ground level
e) 45 from the ground level

The experiment is done only with right arm and the readings are taken from biceps brachi medial, anterior deltoid and external oblique. After each experiment the subject is advised to take rest to avoid muscle fatigue during next experiment. The subject is made to move the iron box five times for each level of and then allowed to take rest as per the experimental protocol.

3.1 Data Acquisition

The data acquisition is done using LabView(National Instruments .Inc) through National Instruments DAQ card. The data acquisition is done for five seconds and data for the study are taken from the 2nd second to avoid any error. The iron box is moved from the source location to the destination location with one cycle per second.

3.2 Analysis

Raw sEMG signals are filtered using second order band pass filter with a range of 20-400 Hz. The signals are notch filtered with 50 Hz to avoid ac line interference. Thus the line interference is eliminated for each subject. The filtered signals were then full wave rectified.

The data obtained were retrieved in excel sheet. From which the fourier analysis is done. The wilcoxon signed rank test was carried out to find the MPF of the obtained signals.

SEMG signals were analyzed in frequency domain. When a change is experienced by the muscle fatigue, the power spectrum of the sEMG also changes (Van der Hoeven et al., 1993). The mean power frequency obtained in the sEMG data can be used in determining fatigue in muscle action (Allison and Fujiwara, 2002).

The difference in the mean power frequency gives the fatigue difference (Park et al., 2000). The MPF difference formula is given below.

MPF difference=MPF_{after}-MPF_{before}.

4.Results

The MPF difference thus obtained using wilcoxon signed rank test can be correlated with the muscle fatigue difference. The standard deviation is calculated using the formula given above. The obtained results are interesting. The muscle fatigue did not increase linearly with the increase in height of the destination. The bar graph obtained for the MPF difference and Standard deviation with the muscles for each height is shown below

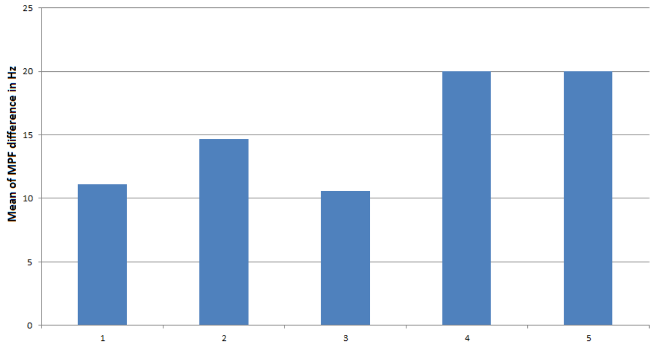

Fig 2 Mean of MPF difference for Biceps Brachi medial

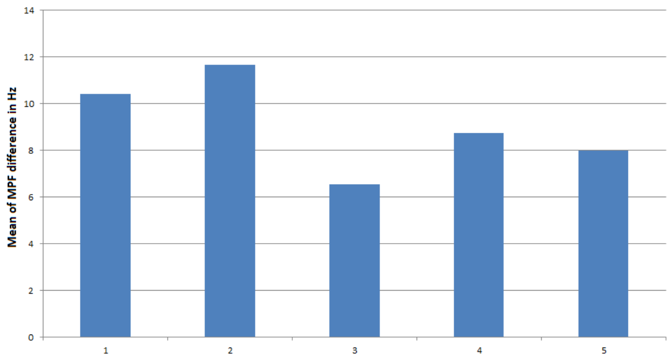

Fig 3 Mean of MPF difference for Anterior Deltoid

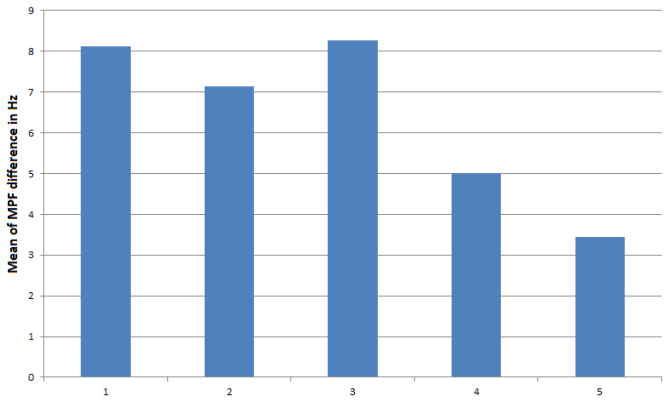

Fig 4 MPF difference for External Oblique

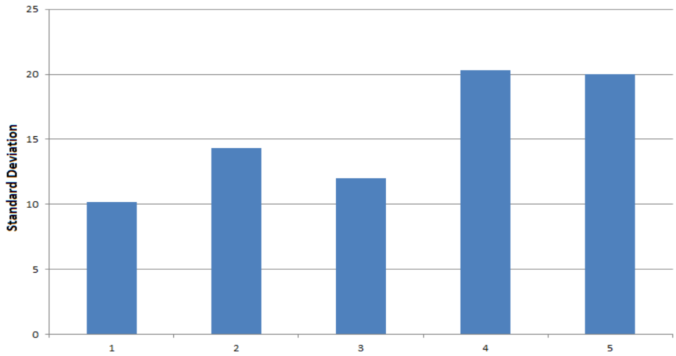

Fig 5 Standard deviation of MPF of Biceps Brachi Medial

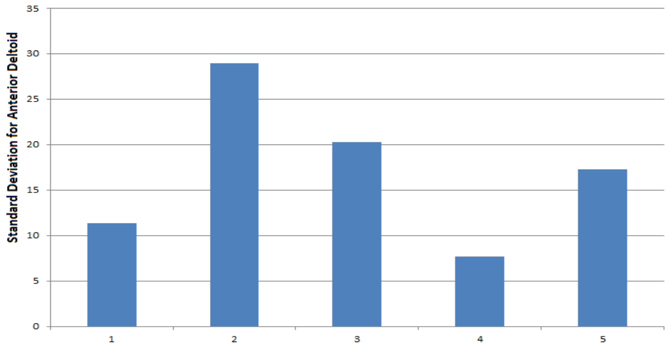

Fig 6 Standard Deviation of Anterior Deltoid

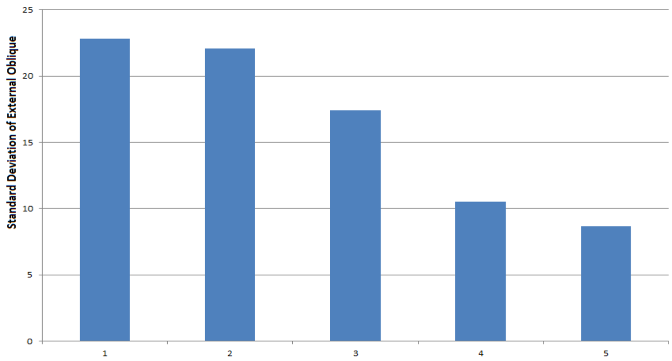

Fig 7 Standard Deviation of External Oblique

(1-34cm, 2-38cm, 3-40cm, 4-42cm, 5-45cm)

Table 1 MPF and SD values Obtained for the three muscles

s.no	BBM		AD		EO	
	MPF	SD	MPF	SD	MPF	SD
1	11.0838	10.17116	10.41633	11.30556	8.1295	22.8039
2	14.70776	14.31566	11.64979	28.95495	7.142	22.0639
3	10.61305	12.02196	6.547964	20.2477	8.2676	17.4351
4	19.99195	20.33225	8.745436	7.698443	5.0206	10.5079
5	20.00652	20.00098	7.992221	17.30164	3.4358	8.6824

BBM-Biceps Brachi Medial, AD-Anterior Deltoid, EO-External Oblique.

5.Discussion

The fig 2 shows the MPF difference of biceps brachi medial. From the figure, it is inferred that the MPF at the height of 46cm is minimum and we can also infer that MPF keeps on increasing from the lowest to the highest table height. The obtained MPF difference values are in the range obtained for the biceps brachi medial for the control group (V. Balasubramanian et al).

The fig 3 shows the MPF difference of anterior deltoid. From the figure we can infer that the MPF at the height of 46cm is comparatively low. It shows that the muscle activity of the anterior deltoid is lower at this height compared to other heights. The obtained MPF difference values are in range obtained for the anterior deltoid by S.P.McCully et al (2007).

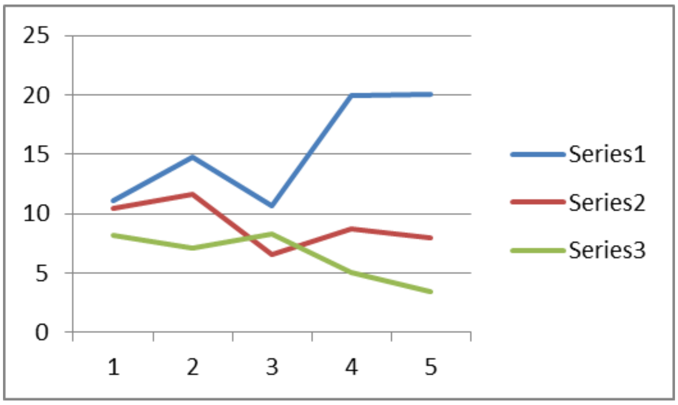

Fig 8 Comparisons of MPF difference

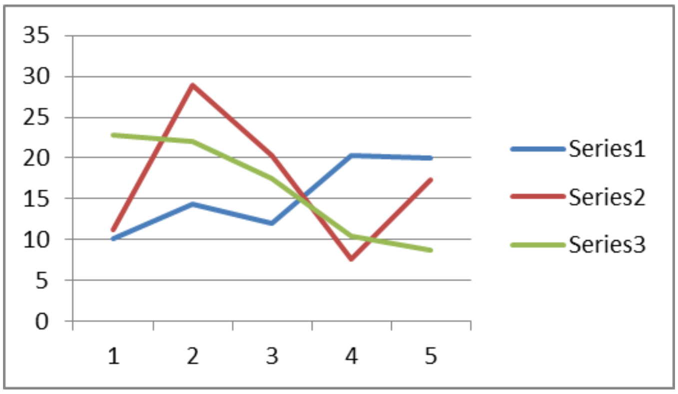

Fig 9 Comparisons of SD

Series 1- Biceps Brachi Medial, Series 2- Anterior Deltoid, Series 3- External Oblique.

With The fig 4 shows the MPF difference of External Oblique. From the figure we can infer that the MPF at the height 166.5cm is the lowest i.e., the muscle activity at that height is very low. Note that the subjects involved in the study are in the height range of 169-173cms. So, this height of 166.5cm will be above the shoulder height. The obtained range of values match the external oblique values obtained by Gwendolen Jull (1993).

The figure 8 shows the comparison of MPF between the three muscles: biceps brachi medial, anterior deltoid and external oblique. It can be observed from the figure that the MPF difference of the biceps brachi medial and anterior deltoid are at the lowest in the third process. But in the case of external oblique, the MPF difference is highest in the third table height and lowest in the top most table height.

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