Proceedings of the IEEE-EMBS International Conference on Biomedical and Health Informatics (BHI 2012)
Hong Kong and Shenzhen, China, 2-7 Jan 2012

Assessment of Upper Body Muscle Activity during *Salat* and Stretching Exercise: A Pilot Study

Fatimah Ibrahim, *MIEEE* and Siti A. Ahmad, *MIEEE*

***Abstract*— Salat is the practice of formal prayer for Muslims. It involves with both spiritual and physical acts. This paper presents electromyography (EMG) output during the *"takbeeratul-ihram (TI)"*, one of the postures in *Salat* and stretching exercise. Comparisons on EMG outputs between *TI* and stretching exercise are discussed. Ten healthy participants (five males and five females) were recruited for the investigation. The EMG signals were recorded from back scapula, upper trapezius, biceps brachii and pectoralis major muscles. The results showed that higher EMG signals in pectoralis major and biceps during performing the stretching posture. However, for TI posture, the EMG activities are higher in back scapula and upper trapezius muscles.**

Keywords-salat posture; takbeeratul-ihram, electromyography; standing; posture, stretching

I. INTRODUCTION

Salat is an act of prayers that is a must for all Muslims. It is a spiritual act that involves with physical acts as well and must be performed at least five times a day.

There are several movements involve during salat namely standing, takbeeratul-ihram (TI), bowing, prostration and sitting. The movements are performed repeatedly, in accordance to the prayer regulations [1]. From this consecutive movement, salat can be considered as a slow moderate exercise.

It can be seen that this various motions during *salat* has psychological, musculoskeletal and cerebral effect on the human [1]. During the performance of *salat*, most of the muscles and joints of the body are involved. This activity is convenient for all kinds of patients, including children and the elderly, for strengthening their muscles as well as the mind. All adults need exercise at least 30 minutes a day to improve and maintain health. By performing salat five times a day, the doers are able to do exercise in the same time.

Manuscript received October 24, 2011. This work was supported in part by the Malaysia Prime Minister's Department through a Special Grant: Project number 66-02-03-0061/H-00000-37039

F. Ibrahim is with the Medical Informatics and Biological Micro-electro-Mechanical Systems (MIMEMS) Specialized Lab, Department of Biomedical Engineering, Faculty of Engineering, University of Malaya, 50603 Kuala Lumpur, Malaysia (Phone/Fax: 603-79676878; e-mail: fatimah@um.edu.my)

S. A. Ahmad is with the Department of Electrical and Electronic Engineering, Faculty of Engineering, Universiti Puta Malaysia 43400 Serdang, Selangor, Malaysia. She is also currently with the Medical Informatics and Biological Micro-electro-Mechanical Systems (MIMEMS) Specialized Lab, Department of Biomedical Engineering, Faculty of Engineering, University of Malaya, 50603 Kuala Lumpur, Malaysia as a postdoctoral officer. (e-mail: sanom@eng.upm.edu.my).

There are wide interests in researching the effect of different salat's movement to the human, which includes psychological or musculoskeletal effect. For example Fatimah Ibrahim has been actively involved in carrying out various researches on salat movement from science perspective [4]. It has been reported that correct salat postures will result to a human good health that include cardiovascular system, body composition and the optimum body posture. Among her works is investigation on the body composition measurement resulting from *salat taraweeh* and fasting for Muslim people [4]. From the research, they found that those two activities gave benefit to the overall human health. She and her team have also investigated the heart rate activities during different salat positions. The study found that the different *Salat's* positions produced a unique pattern of HR changes. The values of HR seemed to change proportionately with the distance of the heart from the ground/ gravity and the position of head relative to the heart [5].

This paper presents the investigation of the EMG activities of the upper body during *TI* in salat. The study focuses on the TI posture performed by male and female participants. In the TI posture, at a standing position, both hands are then raised up to the level of earlobes with the fingers slightly apart (*TI* posture). The TI posture was then compared to the stretching exercise. In stretching, they will do the same movement but they have to stretch their hands away to the back until they can feel the muscles at the upper back area contract. Four muscles were investigated namely back scapula (SC), pectoralis major (PM), biceps brachii (BB) and upper trapezius (UT)

II. METHODOLOGY

A. Subjects

Subjects are chosen among students of University of Malaya who are healthy. Ten subjects (five males and five females) aged between 19 to 28 years old were recruited in this study.

B. Procedures

Every subject was instructed to do two postures namely TI and stretching postures. Both postures are shown in Figure 1. For each posture, it took about 20 seconds in performing them. There will be a short rest period between the EMG measurements to avoid and minimize fatigue to the subjects. The flow chart of the procedures is shown in Figure 2

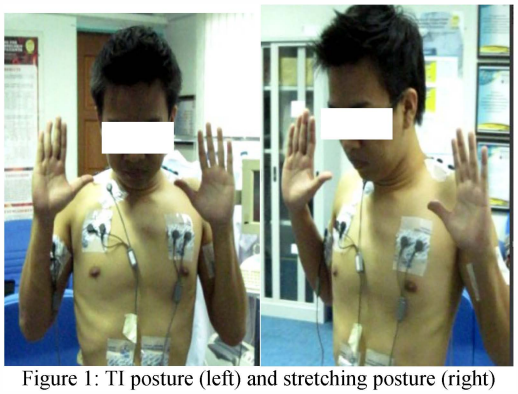

Figure 1: TI posture (left) and stretching posture (right)

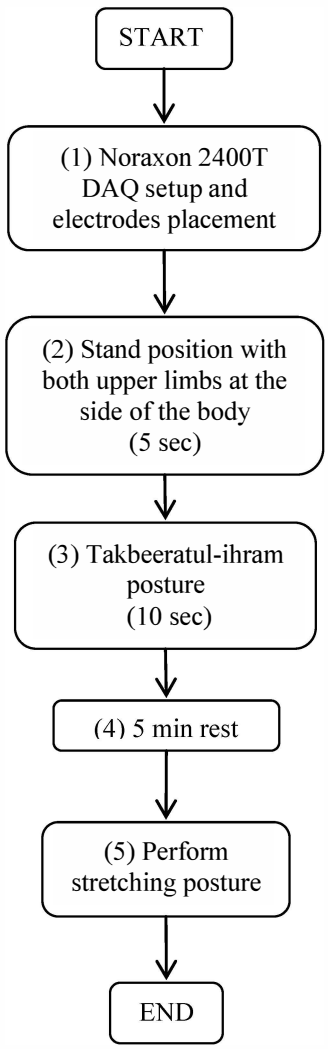

Figure 2: Flowchart of the EMG acquisition procedures

C. Data Acquisition

Subjects have sticky electrodes attached to the surface of their skin of the investigated muscles. Prior to the electrodes placement, the skin was cleansed with alcohol swabs to reduce the impedance of the surface. For the study, the EMG signals are captured from four different muscles which are back scapula, trapezius upper, biceps brachii and pectoralis major from both right and left sides of the body.

To obtain a stable and maximum pick up area of the EMG signals from each subject, the procedure for the EMG electrodes placement are referred from SENIAM [6]. Electrodes were placed at both right and left sides of the body. Figure 3 shows the electrodes placement for both anterior and posterior muscles.

The EMG signals were sampled at 1,000 Hz using Noraxon 2400T in conjunction with Noraxon Myoresearch XP Master Edition (version 1.06) software.

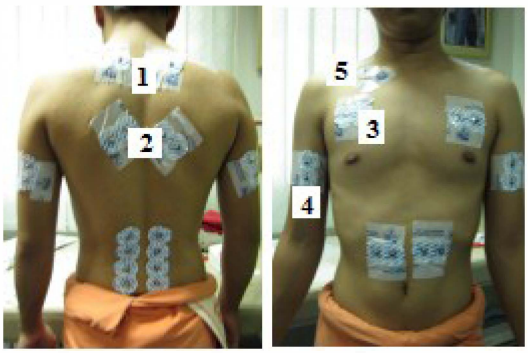

Figure 3: The electrodes placement on posterior and anterior muscles.1: upper trapezius, 2: back scapula, 3: pectoralis major, 4: biceps brachii and 5: ground

D. Data Analysis

All the recorded EMG data were post-processed data using the built-in processing tool in Noraxon, where the RMS values were obtained. In the RMS calculation, the raw signals are rectified and then be converted into an amplitude envelope. The equation for RMS is given in equation (1) below.

$$\mathrm{RMS} = \sqrt{\frac{1}{N}\sum_{i=1}^{N} EMG(i)^2} \qquad (1)$$

Mann-Whitney non-parametric was used to determine the significant level between *TI* and stretching postures for $p<0.025$.

III. Results

All the recorded EMG data show three phases of muscle contractions. The first phase is during standing where no muscles activity except the baseline signals. The second phase began when subjects started to perform *TI/* stretching postures; there are changes in the EMG amplitudes that show the muscles contracted. The final phase is when the subjects were back to the initial position where no muscles activity happens.

The recorded EMG data were then post-processed. Signals were first segmented to 10s period and the RMS values of the signals were calculated. The RMS value for the *TI* and stretching postures are shown in Tables 1 and 2

respectively

TABLE I: The RMS value for TI posture

	PMR	PML	BBR	BBL	UTR	UTL	SCR	SCL
1	11.7	16.5	24	32.6	4.42	0.38	13.8	21
2	4.72	9.67	10.2	12.3	73.3	46.6	16.2	19.7
3	6.4	10.6	20.9	27	123	0.37	23.3	28
4	6.48	23.9	8.86	129	9.86	36	37.5	41.7
5	7.66	10.1	28.3	145	86.9	92	24.6	27.2
6	3.91	11.8	62.7	52.2	28.9	26.5	20.6	17.9
7	6.34	18.9	17.8	150	5.57	24.3	11.7	29.6
8	10.7	19.6	31.5	87.1	17.7	30.1	14.2	9.22
9	8.35	13.8	22.6	151	3.62	0.38	13.5	10.9
10	8.5	15.4	11.2	35.3	54.2	23	22.9	17.3

PMR – Pectoralis Major Right, PML – Pectoralis Major Left, BBR – Biceps Brachii Right, BBL – Biceps Brachii Left, UTR – Upper Trapezius Right, UTL – Upper Trapezius Left, SCR – Scapula Right, SC L – Scapula Left

TABLE II: The RMS value for strectching posture

	PMR	PML	BBR	BBL	UTR	UTL	SCR	SCL
1	13.1	17.3	10.2	15.9	3.77	0.38	21.5	27.2
2	5.51	10.6	16.2	24.7	136	107	38.2	28
3	9.71	13	23	29.8	108	0.37	21	34.8
4	10.9	29.6	6.52	12.5	33.5	70.6	27.9	28.3
5	10.6	14.8	47.6	334	199	179	39.8	50
6	4.39	14.7	55.5	47.4	24.3	31.3	18.4	24.2
7	4.15	17.5	21.3	72.4	28.5	384	6.86	47
8	11.5	21	30.3	180	11.6	20.6	17.6	10.5
9	9.18	13.7	23	39.3	5	0.38	20	22.7
10	10.4	14.9	33.7	16	35.7	110	25.2	25.8

PMR – Pectoralis Major Right, PML – Pectoralis Major Left, BBR – Biceps Brachii Right, BBL – Biceps Brachii Left, UTR – Upper Trapezius Right, UTL – Upper Trapezius Left, SCR – Scapula Right, SC L – Scapula Left

The average RMS for all the investigated muscles are plotted in Figures 4 and 5 for *TI* and stretching postures respectively

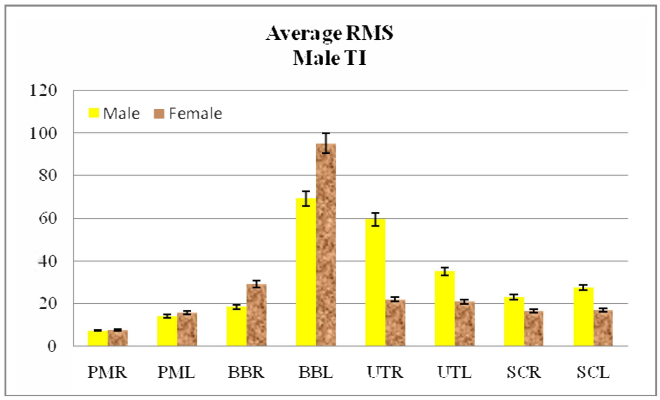

Figure 4: Average RMS value for TI posture

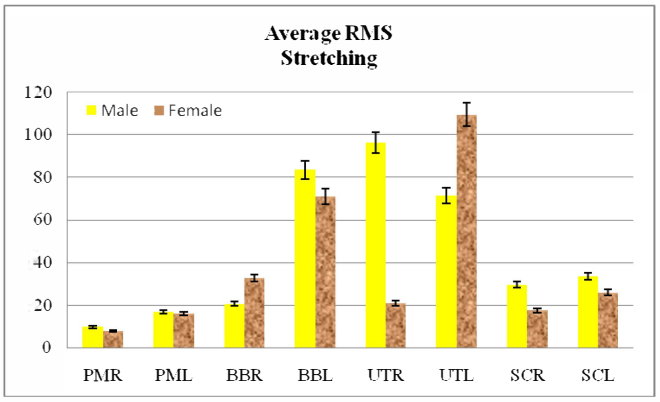

Figure 5: Average RMS value

The Mann-Whitney results show that there are no significant differences in the EMG RMS values in the investigated muscles during TI and stretching postures. Thus, it shows that the same EMG activities can be observed in these two postures.

IV. Discussions

Four muscles at both left and right were investigated in this study. The investigated muscles were as follows: pectoralis major right (PMR), pectoralis major left (PML), biceps brachii right (BBR), biceps brachii left (BBL), upper trapezius right (UTR), upper trapezius left (UTL), back scapula right (SCR) and back scapula left (SCL). Both male and female participants were asked to the *TI* standing and stretching postures.

Figure 4 shows the average RMS values during *TI* posture performed by male and female participants. From the plot, it shows that higher EMG activities in PM and BB but lower in UT and BS in female subjects. The average RMS values for stretching are shown in Figure 5. The same pattern follows like in the *TI* posture except for the UTL, where the value is higher in female subjects.

In comparison between *TI* and stretching postures, higher muscle activities can be observed from BBR and UTR when performing *TI* posture. This also follows when doing stretching with additional high activity in UTL. This is expected as stretching requires more energy compared to the *TI* posture. However, from the statistical analysis, there is no significant different between these two postures.

In general, the result obtained shows that the muscle activity during standing with stretching is higher compared to TI posture. During stretching, most muscles were involved as observed from the EMG signals. BB and UT show the most visible changes based on the result obtained. During hand lifting, an external shoulder moment generated to stabilize the joint position. When the level of hand lifting increased, the external shoulder moment will increase and the muscle activity increase to support the external shoulder moment. During standing with stretching, the forearm was lifted with higher degree than standing with *TI* posture. Thus, the muscle activity during standing with stretching is higher compared to *TI* posture and this is supported by the work of Antony and Keir [7].

In general, when moving the arm to the specified locations for each posture, there are muscle activities for the four muscles which are PM, UT, PM and BB compared when the subject only stood up straight and in rest. This movement is very beneficial to the subjects as it can help smoothed the blood flow, lymph nodes and arm muscle strength. In this movement, the position of the heart is below of the brain which allows blood to flow smoothly throughout the whole body. When the subjects raised both hands and stretched the shoulder muscles, the flow of blood that rich with oxygen become fluent [1].

According to previous research [3, 9, 10], *salat* has proven to promote better health based on brain signal analysis. Certain position of *salat*, such as prostration was capable of producing a state of relaxation of the mind and body [9, 10]. The movement and muscle activity during *salat* might not as high as during performing dynamic exercise like cycling. However, since *salat* is performed five times a day, the repeated and regular movement of body during *salat* will help to improve the muscle strength, joint flexibility, and cardiovascular reserve [1, 3, 8]. Combination of *salat* and moderate dietary control can improve body weight control and expend calories [3, 4]. This will help to reduce body fat mass and body weight without significant changes on the fat free mass [8]. Regular mild exercise and body weight control as results from performing *salat* should promote to better health.

V. CONCLUSIONS

The results have shown that there is no significant difference between *TI* and stretching postures. Thus, these findings indicate that the effect of posture and movement of *salat* are as good as stretching exercise because all the upper muscles are being activated. By performing *salat* consistently every day for the spiritual act; *salat's* physical act mimics the stretching exercise and beneficial good for the human health and longevity [11].

Acknowledgement

The authors would like to express the the following individuals as follows: Nor Baizura Ahmad Suki, Ku Pei Xuan, Hay Yuen Yan, Gan Sze Yin for conducting the experiments.

References

[1] MF. Reza, Y. Urakami, and Y. Mano, "Evaluation of a New Physical Exercise Taken from Salat (prayer) as a Short Duration and Frequent Physical Activity in the Rehabilitation of Geriatric and Disabled Patients" Annals of Saudi Medicine, vol. 22 (3-4), 177–180 , 2002.

[2] Abdal-Hakim Murad, "Understanding the Four Madhhabs", URL: http://www.masud.co.uk. Accessed on: 6th June 2011.

[3] Fatimah Ibrahim, Wan Abu Bakar Wan Abas, Ng Siew Cheok. Salat: Benefits from the Science Perspective. Department of Biomedical Engineering, Faculty of Engineering, University of Malaya, 2008.

[4] Mohktar, M.S., & Ibrahim, F. Assessment of Salat Taraweeh and Fasting Effect on Body Composition, International Proceedings of the International Federation for Medical and Biological Engineering (IFBME), Springer 2008, June 25-28, 2008.

[5] Ibrahim, F., & Wan Ahmad, W.A. Study of Heart Rate Changes in Different Salat's Positions, International Proceedings of the International Federation for Medical and Biological Engineering (IFMBE), Springer 2008, June 25-28, 2008

[6] Hermans, H., Freriks, B., Merletti, R., Stegeman, D., Blok, J., Rau, G.,Disselhorst-Klug, C. and Hagg, G. SENIAM 8, European Recommendations for surface Electromyography, results of the SENIAM project. RossinghResearch and Development, 1999.

[7] Antony, N. T., & Keir, P. J. Effects of Posture, Movement and Hand Load on Shoulder Muscle Activity. Journal of Electromyography and Kinesiology, *20*, 191-198, 2010

[8] Salahuddin, M.H.R., Wan Abas, W.A.B., Abu Osman, N.A, Ibrahim, F., & A.Rahim, R.B. 2008. Preliminary Study: The Impact of Moderate Exercises on Biomechanical Response of the Humans Muscles, International Proceedings of the International Federation for Medical and Biological Engineering (IFBME), Springer 2008, June 25-28, 2008

[9] Hazem Doufesh, Tarig Faisal, Lim Kheng Seang, Fatimah Ibrahim, EEG Spectral Analysis On Muslim's Prayer. Journal of Applied Psychophysiology and Biofeedback. DOI: 10.1007/s10484-011-9170-1

[10] N.A. Salleh, K.S. Lim, F. Ibrahim, AR Modeling as EEG Spectral Analysis on Prostration, 2009 International Conference for Technical Postgraduates (TECHPOS), 1-4, 2009.

[11] Ibrahim F, Effect of Salat in Health and Longevity, Proceeding of the 16th Shizuoka Forum on health and lonvevity, "Creation of Health Longevity Society by integration of different fields of Science", the Shizuoka Forum, Shizuoka Japan, 21-22 October 2011.