Electromyographic Activity of the Upper Limb Muscle during Specific Salat's Position and Exercise

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***Abstract*—This study investigated the muscle activity of the neck extensors (NE), sternocleidomastoideus (SCM) and biceps brachii (BB) muscles in healthy subjects during *salat* and specified exercises using surface electromyography (EMG). A group of undergraduates aged between 19 to 25 years voluntarily participated in this study. For the assessment of the NE and SCM, the subjects were asked to perform *salat* (*salam's* position) and exercise [neck rotation exercise (NRE)]. Subjects were asked to perform *takbir's* position and biceps dumbbell curl (BDC) to access BB. The EMG and the motion signals of the muscles were recorded. The findings indicate that there were contractions of the muscles during the *salat* and exercise with difference EMG level. For NE and SCM, Wilcoxon's Rank Sum Test showed a statistically no significant difference between *salat* and exercise for NE ($p = 0.482$) and SCM ($p=0.161$). For the BB, Wilcoxon's Rank Sum Test showed a statistically significant difference between *salat* and exercise ($p<0.05$) with differences 18.48% MVC. However, BB showed the EMG level with mild contraction. Therefore, *salat* may be useful in warm up exercise or in rehabilitation programs. This pilot study can be as initial research about other biomechanical response of human muscle with other position in *salat*.**

***Index Terms*—Electromyography, *salat's* position, exercise, upper limb.**

I. Introduction

The electrical activity in the human muscles can be measured using electromyography (EMG). This allows for the measurement of the change in the membrane potential as the action potentials are transmitted along the fiber. The study of the muscles from this perspective can be valuable in providing information concerning the control of voluntary and reflexive movement. The study of muscle activity during a particular task can yield insight into which muscles are active and when the muscles initiate and cease their activities [1].

Salat is a ritual Islamic prayer that's given by all those practicing the Muslim religion five times a day. *Salat* shows an individual's dedication to God and is considered the most important act of worship. *Salat* has precise steps that all Muslim all over the world must perform. The various motions of the *salat* include standing, bowing, prostration, and sitting. The joins that are involved in the movements are the shoulders, wrists, elbows, metacarphophalangeals (MP), proximal interphalangeals, distal interphalangeals, temporomandibular, vertebral column, hip, knee, ankle, subtalar, metatarsophalangeal, and antanto-axial [2].

There are a lot of exercises that give benefit for neck and biceps brachii. Burnett et al [3] study on activation levels of selected neck muscles for two common neck-training modalities (Thera-Band and Cybex). They found that Thera-Band exercise resulted in low-level EMG activation (range, flexion 3.8-15.7% MVIC; range, extension 20.2-34.8% MVIC); therefore, such exercise may be useful in rehabilitation programs. Cybex exercise (range, flexion 20.9-83.5% MVIC; range, extension 40.6-95.8% MVIC) may be useful for occupation-related injury prevention. For the biceps dumbbell curl (BDC) is one of the resistance training exercises. It is mostly applied to overload the musculoskeletal system, leading to the accelerated enhancement of muscle strength [4].

From the current research, it is possible to identify the muscles that are involved and contract during *salat* and can give benefit in muscle health. The experiment can also serve as a pilot study on the biomechanical response of human muscle during the Muslims' prayer, or the *salat*.

II. Methodology

A total of 14 subjects undergraduates (age: 19.5 ± 5.1 years) with no medical history were recruited as subjects of the study. 7 subjects from them perform *salam's* position and NRE and the other 7 subjects perform *takbir's* position and biceps dumbbell curl (BDC). They read and signed a consent form prior to participating in the experiments. Three repetitions were recorded for every *salat* and exercise protocol.

Disposable bipolar Ag-AgCl disc surface electrodes with a diameter of one cm were affixed over the chosen muscle groups, parallel to their fiber orientation in the muscle belly. The electrodes were connected to an EMG data collection system (Myomonitor IV Wireless Transmission, Delys) and the signals were collected using customized software (Delys EMGWorks, Boston, MA, USA). The EMG bandwidth was 10-500Hz at a sampling rate 1500Hz. The electrodes were placed according to the SENIAM recommendation [5]. The current study involved EMG recording of three muscles, namely the neck extensors (NE), sternocleidomastoideus (SCM) and biseps brachii (BB).

During *salam's* position, subject sit on the left leg with both hand are placed between the thigh and knee. Turn their head 90^0 from middle towards his right and left and hold for 5 seconds for each direction. During NRE's position, subject standing upright, turn his head to right and left (90^0 from middle) with his hand and hold for 5 seconds for each direction. For the *takbir's* position, subject standing upright

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with his hands rise to level of ears and hold for 5 seconds. For the BDC's position, subject standing upright holding dumbbell (3 kg). Then raise the dumbbell with his elbow in flexion position for 90^0 and forearm in supination. Hold this position for 5 seconds and 3 seconds subsets for each position were selected.

Electrode placement was preceded by palpation and visual inspection of each of the muscles. A ground electrode was placed on the medial epicondyle. Electrode placement was verified by inspection of the signal during voluntary contraction. For the NE, the electrode was placed bilaterally on the paraspinal muscle at 2 cm lateral of the *C*4 spinous process; SCM, along the sternal portion of the muscle, with the electrode on 1/3 of the distance between the mastoid process and the sternal notch and for BB the electrode was placed midway between the elbow and the midpoint of the upper arm, on the muscle midline

To normalize the EMG signals, a record was made of the maximum voluntary contraction (MVC) for the all muscles involved in the experiment. To obtain stable maximum force prior to formal EMG data collection, enough practice time was allowed for warming-up and for the subjects to familiarize themselves with the testing procedures. Subjects maintained the same level of contraction for 5 s and the 3 s with the most constant root mean square (RMS) EMG signal were selected and used to represent the normalized value (100% MVC).

Both the EMG level during *salat* and exercise were identically processed. The EMG signals were analyzed using EMG analysis software version 3.5.1.0, (EMGWorks, Delsys, Boston, MA), then RMS technique was used to smoothen the data thus producing a linear envelope of EMG activity record. The values of all RMS were averaged and then normalized as % MVC. Then, each position of *salat* and exercise were compared.

III. Result

The experimental results of the EMG signals for all the subjects indicate that there were contractions for all of the muscles during *salat* and exercise. EMG average in % MVC for NE was 54.96% during *salat* and 55.20% during exercise; SCM, 52% during *salat* and 44.38% during exercise and for BB showed that 17.7% during *salat* and 36.26% during exercise. NE and SCM produce almost same level of EMG for *salat* and exercise but BB shows exercise produce higher EMG level than *salat* with difference about 18.48% MVC.

When comparing the mean EMG level, exercise shows higher EMG level than *salat* with differences 0.34% MVC for NE and 18.47% MVC for BB. On the other hand, SCM shows higher EMG level for *salat* compare to exercise with differences 7.62% MVC.

Although NE produced a litter bit higher EMG level during exercise compare to *salat*, Wilcoxon's Rank Sum Test showed a statistically no significant difference between *salat* (*salam's* position) and exercise (NRE) (p=0.484). For SCM, *salat* produce EMG level higher than exercise but Wilcoxon's Rank Sum Test shows statistically no significant difference between *salat* (salam's position) and exercise (NRE) (p=0.161). For BB, exercise produced higher EMG level than *salat* and Wilcoxon's Rank Sum Test shows statistically significant difference between *salat* (*takbir's* position) and exercise (BDC) (p<0.05).

TABLE I: Result of *Salat* and Exercise

Posture	Median	Interquartile Range	Z	p
Neck Extensor				
Salat	59.43	36.51	-0.700	0.482
Exercise	58.16	36.83		
Sternocleidomastiod				
Salat	53.05	15.56	-1.400	0.161
Exercise	44.94	14.89		
Biceps brachii				
Salat	15.56	35.25	-2.521	0.012
Exercise	15.18	14.15		

IV. Discussion

This study showed that *salam* and NRE are statistically same in EMG level activity. This can be one of the warm-up exercise or strengthening exercise for our neck muscle especially neck extensor muscle and sternocleidomastoid. Patients can do rehabilitation program of neck strengthening exercises as well as stretching exercises to increase flexibility. It is recommended to help prevent re-injury and pain. There are a lot of benefits for neck exercise. For example, several randomized controlled studies have shown specific neck muscle exercises to be effective treatment in cases of chronic neck pain [6]–[9]. Beside, isometric strength and dynamic endurance training of neck muscles may relieve or even completely eliminate pain and restore function in patients with chronic neck pain [9].

Although *takbir's* position showed lower EMG level than BDC but it still contracts the biceps brachii muscle and flex the elbow in full range of motion (ROM). This position can be one of exercise that increases the flexibility. Flexibility is defined as the terminal range of motion of a segment. This can be obtained actively through some voluntary contraction of an agonist creating the joint movement (active ROM) or passively, as when the agonist muscle are relaxed as the segment is moved through a ROM by an external force, such as another person or object (passive ROM) [10], [11]. BDC is one of the resistance training exercises. Resistance training exercises are mostly applied to overload the musculoskeletal system, leading to the accelerated enhancement of muscle strength [4]. Equipment such as dumbbells, barbells and cable machines are often used in conditioning and strengthening programs [12]. According to a biomechanical model for simulating Dumbbell Biceps Curl (DBC) exercise, the force produced by elbow flexors in quasi-static exercises increases with the load moment arm, which highly affects the direction and magnitude of joint internal forces [12]. It is difference from *takbir*, it only use same force to perform. For further research, we can access other position of *salat* that maybe will produce higher EMG level than *takbir* position.

Muslim is commanded to perform *salat* five times a day. This shows that Muslim perform *salat* regularly according to it routine time. There is a growing realization that regular participation in physical activity can give us a lot of benefit

for our health [13]-[15]. By doing *salat* regularly, maybe it also produce a lot of benefit for our muscles and joints.

V. Conclusion

In conclusion, the *salat* position such as *salam* can be one of the warm-up exercise or strengthening exercise to maintain our neck muscle performance. To every Muslim that performs *salat* 5 times a day automatically was doing exercise for their neck muscle. *Takbir* position also can be one of the warm-up exercises since it produces muscle contraction that enough for doing daily living activity that not require a lot of energy and contraction. It also can be one of the flexibility exercises to maintain ROM for our joints. This pilot study can be useful for therapist in rehabilitation or exercise programs.

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