The Influence of Saracen Archery Grasping Techniques and Forearm Muscles Activation on Shooting Performance in Traditional Archery: A Pilot Study

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Abstract. The purpose of this study is to understand the influence of four grasping techniques recommended by Saracen Archery and associated forearm muscles activation on traditional archer’s shooting performance. Each archer has shot 6 arrows in each grasping technique to the target, EMG activities of muscle Flexor Digitorum Superficialis (MFDS) and muscle Extensor Digitorum (MED) were collected in bow arm during aiming phase. The shooting performance was indicated by the distance from arrow hitting point on the target to the bull’s eye. The results revealed that each subject has specific grasping technique to obtain the best shooting performance. The grasping technique that generated the best performance is not as recommended by Saracen Archery. All subjects indicated that the best shooting performance was obtained when MED activated more than MFDS.

1. Introduction

Saracen Archery was written by Taybugha Al-Ashrafi Al-Baklamishi Al-Yunani, a Mamluk Soldier, in 1386, refers to the method introduced by the Great Masters of archery; Abu Hashim Al Mawardi, Ishaq Ar Raqqi and Tahir Al Balkhi to be applied for new archers [1]. Various archery shooting techniques and methods were thoroughly described in the manuscript. Grasping as the fundamental aspect of the traditional archery, were recommended with respect to the length of the archer’s fingers. In some research works, the forearm flexor and extensor muscle were reported to be significant in holding and grasping the bow to produce best shooting performance [2,3,4]. Thus, if we practice the grasping technique as recommended in Saracen Archery, does each technique produce difference extensor and flexor muscle activation amplitude and finally, affect the shooting performance? Does each subject generate different performance when using different grasping technique? Does any of the two muscles has tendency to produce a better performance? If the answers to these research questions are yes, then, some suggestions could be made to the traditional archery coach to further improve their training methods. Thus, the aim of this study is to investigate the influence of the grasping techniques.
recommended by Saracen Archery and forearm muscles i.e M. Extensor Digitorum (MED) and M. Flexor Digitorum Superficialis (MFDS) on generating a good shooting performance. This study is in collaboration with Akademi Panah Emas, a local private company focusing on traditional archery trainings and organizing competitions in the state of Kedah, Malaysia to explore the effect of grasping techniques as recommended in Saracen Archery.

2. Method
2.1. Subject
There are four healthy traditional archers with experienced more than 4 year, three males and one female participated in this pilot study. The mean and standard deviation of height and body weight are 1.64 ±0.06 m and 70.1±25.1 kg, respectively. All participants were physically active, free from rotator cuff injuries, tendinitis and had no history of muscle strain.

2.2. Equipment
Three-dimensional kinematics data were obtained using 5 Oqus cameras of motion capture system (Qualisys AB, Goteborg, Sweden) that attached firmly on tripods and connected to a computer to capture the motion of subjects operated at 200Hz. Six reflective markers were adhered bilaterally to participant shoulder, elbow and wrist. An additional marker was attached to the right thumb of the subject for detecting the release point. The EMG activity was recorded using four channel BioRadio 150 as shown in Figure 1 with a sampling frequency of 950 Hz. Three disposable single polar surface electrodes were attached to each muscle involved in the study i.e., left MED, and left MFDS. The electrode placement of test sites is according to SENIAM’s project recommendations [5].

![Figure 1. Bioradio 150](image)

2.3. Experimental Protocol
The subjects were instructed to wear tight shirts and required to warm-up. A five second data set was collected with the subject’s arm relaxed and followed by a maximal voluntary isometric contraction (MVIC) designed to elicit maximal activation in each muscle. The MVIC session was carried out for three trials. After performing the MVIC exercises, the subject position themselves and initiated arrow shootings to familiarize with the experiment.

Each participant engaged in four shooting sessions involving 6 shots per session for the distance of 5 meters in the Biomechanics Laboratory of Universiti Malaysia Perlis. Each session refers to a type of bow’s grasping technique namely, intermediate, square, oblique, and combination technique and assigned in randomized order. Those techniques are as shown in Figure 2. In the Square technique, the spine of the bow, must be placed centrally in the middle crease form between the proximal phalanx and middle phalanx. In the Oblique grasping technique, the spine of the bow is placed in the first crease, which is the line between the base of the fingers and the palm. In the Intermediate grasping technique, the spine of the bow is placed in the centre of the proximal phalanx. The Combination technique was directly informed by the coach to the archers as it is considered confidential. In each session, subject was reminded to grasp the bow according to the recommendation and was provided with a one-minute
break to prevent fatigue. The score for each shot and the distance from the centre of target (bullseye) to the point where the arrow hit the target was recorded.

![Grasping techniques](image)

**Figure 2.** Recommended grasping techniques and fingers size

### 2.4. Data Analysis

EMG and maximum voluntary contraction (MVC) were undergoing bandpass filtered using a Butterworth filter with a lower cut-off frequency of 20Hz and higher cut-off frequency of 450Hz and full wave rectification using MATLAB. Kinematic data were low-pass filtered using a fourth-order, zero-lag Butterworth filter with a cut-off frequency of 6 Hz. Both EMG and kinematic signals were synchronized manually by the fast vertical movement of the left hand prior to the shooting trials. By observation of the signal, consistence grasping occurs during the aiming phase, thus, only 1 second of EMG data before the release point was considered for analysis. The arrow release point was estimated using a single marker attached to the right thumb of the participants. The maximum value of MVC was chosen for normalizing the acquired EMG signals during shooting. The shooting performance was quantified using the distance measured from the arrow hitting point to the bull’s eye of the target. Thus, the closer the distance between the arrow hitting point to the bull’s eye indicates a better shooting performance.

### 2.5. Statistical Analysis

Statistical analysis was performed using the IBM SPSS Statistics version 22.0. Statistical significance was set at $p < 0.05$.

### 3. Results and Discussion

#### 3.1. Does the grasping technique and muscle activities influence the performance?

Only data for the fourth archer did not pass the normality test. Non-parametric Friedmann test was carried out for the fourth archer and One-way repeated measure Anova was performed on the other archers to test the effect of grasping technique on shooting performance. In the first archer, the main effect of grasping techniques on shooting performance were found to be significant, $F(1.89, 9.46) = 4.66, p <0.05$. Post Hoc test indicated that the Intermediate grasping technique produces better shooting performance when compared with other techniques. This could be confirmed from Figure 3; the first archer obtained the best shooting performance in the Intermediate grasping technique, followed by almost similar performance in the Square and Combination technique, and the lowest performance in the Oblique grasping technique. No significant main effect of grasping technique on shooting performance was found for the other subjects although differences between shooting performance in each grasping techniques were shown in Figures 4, 5 and 6. In general, the best shooting performance of each archer was not necessarily associated with the highest muscular activities across the grasping technique. Each archer generated their best performance at a specific grasping technique.
**Figure 3. Archer 1**

**Figure 4. Archer 2**

**Figure 5. Archer 3**
In evaluating the effect of muscle activation on performance of each archer, a comparison between muscles were made with respect to their best shooting performance. Table 1 shows the highest normalized muscle activation and statistical test for each archer in each grasping technique. Most of the archers indicated a significantly higher MED muscle activities compared to MFDS except for the fourth archer. Moreover, it was found that most of the archer’s best shooting performance was associated with a higher extensor muscle activity. These findings were supported by the results of the study by Musa et al., forearm’s extensor muscle of the medallist modern archer is highly activated throughout the aiming and releasing phases [4]. Ertan et al.[2] reported that activation of MED only or not activating the MED and MFDS in modern recurve archery could prevent producing a torque or twisting the bow when the arrow is released. Perhaps, these are the reasons for all archers obtained the best shooting performance when forearm extensor activation is the highest, combined with the best technique that suit each archer.

### Table 1. Highest normalized muscle activation in each grasping technique

| Archer | Combination | Square | Intermediate | Oblique |
|--------|-------------|--------|--------------|---------|
| 1      | *MED        | *MFDS  | *MED, Best   | *MFDS   |
| 2      | **MED       | MFDS   | **MFDS       | **MED, Best |
| 3      | *MED        | MED    | *MED         | *MED, Best |
| 4      | *MFDS       | MED, Best | *MED        | MFDS    |

*Wilcoxon signed rank test – \( p<0.05 \). MED – indicate that MED magnitude is higher than MFDS.

**Dependent t test – \( p<0.05 \)

#### 3.2 Does the grasping techniques associate with the height of the subjects as recommended by Saracen?

Table 2 indicates the height of each subject, and recommended grasping technique based on their height as described in Saracen Archery and the grasping technique which produced the best score during the experiment.

### Table 2. Recommended grasping and best grasping during experiment

| Archer | Height (cm) | Recommended Grasping Technique by Saracen Archery | Best Grasping Technique during experiment |
|--------|-------------|--------------------------------------------------|-----------------------------------------|
| 1      | 170.6       | Square                                           | Intermediate                           |
| 2      | 167         | Intermediate                                     | Oblique                                |
| 3      | 166         | Intermediate                                     | Oblique                                |
| 4      | 155         | Oblique                                          | Square                                 |

Figure 6. Archer 4
In Saracen Archery, it is recommended that a tall person should grasp squarely, a medium person should grasp using intermediate technique, and the short person should grasp obliquely. Based on the experiment, the first archer who is the tallest, produced the best performance in the Intermediate technique. The second archer and third archer who were assumed to be in Intermediate grasping group, scores the best in the Oblique grasping technique. The fourth archer who is the shortest among the archers (155 cm) shows a best performance in the Square grasping technique. Although none of the archers generated result as recommended by the Saracen Archery, perhaps there are other dominant factors including other anthropometric parameters could influence the archer’s performance such as abdominal circumference, arm span, thigh circumference and weight [6]. There is also a possibility that each subject is utilizing a grasping technique that almost similar to the best grasping technique that produced best shooting performance in this experiment. However, this was not confirmed before the experiment. Understanding their current technique is important before carrying out similar experiment in the future.

4. Conclusion
This preliminary study helps us to concluded that a higher contraction of extensor muscle compared to flexor muscle generates best archery shooting performance. There is a specific grasping technique that produce the best shooting performance for each archer. However, it was found that the grasping technique is not corresponded to the height of the subject as recommended in Saracen Archery in generating a best performance.

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