THE COMPARISON OF BALANCE ABILITIES OF RECURVE, COMPOUND AND TRADITIONAL ARCHERY: A PRELIMINARY STUDY

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ABSTRACT

Archery is described as a static sport requiring fine movement control, proper endurance and strength of the upper body and balance ability.The purpose of this study was to examine differences in balance abilities during Recurve, Compound and Traditional Turkish Archery. Fourteen archers (Group I: The Recurve Archery (RA): n=5, Group II: Compound Archery (CA): n=4, Group III: Traditional Archery (TA): n=5) participated voluntary in the study. An 9281EA BioKistler Force Plate system was used to obtain objective measurements in medio-lateral (Ay) and anterio-posterior (Ax) directions of the sway of COP during the trials.The RA group displayed a slower COP sway range when compared to the CA and TA groups. The findings of this research suggest that archer drawing weight may affect shooting performance, especially during the releasing phase due to a shift in body weight (COP).

Key Words: centre of pressure, balance, postural sway, archery

OLİMPİK, MAKARALI VE GELENEKSEL TÜRK OKÇULUĞU DENGE YETENEKLERİNİN KARŞILAŞTIRILMASI: ÖN ÇALIŞMA

ÖZET

Okçuluk üst vücudun ince motor kontrolünü, kuvvet, dayanıklılık ve dengesini gerektiren statik bir spor branşıdır. Gerçekleştirilen çalışmada Olimpik, Makaralı ve Geleneksel Türk Okçuluğunda denge yeteneklerinin karşılaştırılması amaçlanmaktadır. Çalışmaya 14 erkek okçu (Grup I: Olimpik Okçu (RA): n=5, Grup II: Makaralı Okçu (CA): n=4, Grup III: Geleneksel Türk Okçu (TA): n=5) gönüllü olarak katılmıştır. Denemeler sırasında mediolateral (Ax) ve anterioposterior (Ay) yönlerdeki basınç merkezi değerlerini ölçmek için A 9281EA BioKistler Force Plate System kullanılmıştır. Olimpik okçu grubu (RA) makaralı (CO) ve geleneksel okçu grup (TA) ile karşılaştırıldığında daha düşük Basınç Merkezi (COP) değerleri sergilemişlerdir. Elde edilen bulgu, okçunun çekiş ağırlığının özellikle, serbestleme evresinde vücut ağırlık merkezindeki değişimden dolayı atış performansını etkileyebileceğini göstermektedir.

Key Words: basınç merkezi, denge, postural salınım, okçuluk

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INTRODUCTION

Balance ability is essential for top athletes in order to reach peak performance. Archery is a good example of a sport where balance is required to achieve high scores. It can be described as a static sport requiring balance, fine movement control, proper endurance and strength of the upper body. In archery, once the archer has aimed and fixed their posture, the fluctuations of the body must be regulated such that the alignment of the arrow remains within the target boundary, and the individual's centre of gravity within their base of support (Balasubramaniam, Riley & Turvey, 2000; Ertan, Knicker, Soylu & Strueder, 2011). Balance ability is related to skill level for archers, with the more proficient archers displaying greater balance ability prior to the arrow shot (Hrysomallis, 2011). Aiming or sight trajectory sways on the target vertically and horizontally, and anterio-posterior and medio-lateral postural sways during release may adversely affect the resulting score (Tinazci, 2011). Archery is classified into two major categories by the International Archery Federation (FITA): (1) recurve or olympic archery and (2) compound archery. In addition, different sub-classifications within traditional archery types also exist (e.g. Turkish Archery, Kyudo). Variables such as bow designs and shooting technique vary across these classifications, and attached to the recurve bow is equipment facilitating bow stabilization and vibration dampening. Such archery specific equipment comprises; long and short rods, v-bars and doinkers as examples. Similarly, though to a lesser degree than the Recurve, the Compound bow also features stabilizing and vibration elimination equipment. In contrast, traditional archers do not employ any form of assistive devices (**Figure 1**).The purpose of this study was to compare the balance profiles of recurve, compound and traditional Turkish archers during a shot.

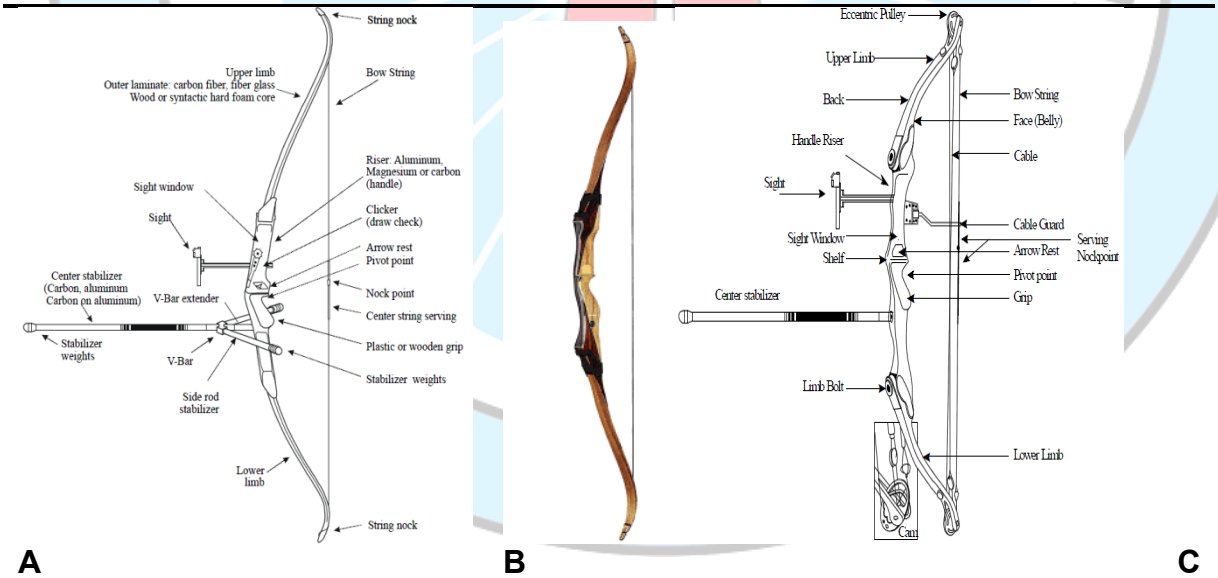


Figure 1: Bow designs of (A) Recurve Bow (FITA) (2010), (B) Traditional Bow (Fadala, 2011) and (C) Compound Bow (FITA) (2010).

MATERIAL AND METHOD

Study Group: 14 male archers (Group I: The Recurve Archery (RA): n=5, Group II: Compound Archery (CA): n=4, Group III: Traditional Archery (TA): n=5) volunteered to participate to the current study. Their descriptive statistics are summarized in **Table 1**. All participants were injury free at the time of testing and none reported a previous injury history to their upper or lower limbs. Three groups, (i) recurve archers (n=5, FITA score = 1211±26.2), (ii) compound (n = 4, FITA score = 1258±15.1) and (iii) traditional archers (n=5) were involved in the study. No FITA scores for traditional archers are available due to no official FITA sanctioned competitions, however the training ages were 6.36±1.34 years indicating that they were experienced archers.

Table 1: Descriptive statistics of archers

Archery Groups (n)	Athletic History (years)	Age (years)	Height (cm)	Body Mass (kg)	Draw and Bow Weight
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Lbs – kg
Group I RA (n=5)	7.83 ± 1.15	26 ± 1.5	175.0 ± 6.1	75.4 ± 4.5	42 – 2.5
Group II CA (n=4)	7.36 ± 1.28	22.2 ± 1.8	182.0 ± 5.3	67.9 ± 5.6	55 – 3.5
Group III TA (n=5)	6.36 ± 1.34	28.3 ± 1.5	178.5 ± 5.3	78.5 ± 5.2	53 – 0.5

RA: Recurve Archery; **CA:** Compound Archery; **TA:** Traditional Archery

The centre of the target was placed directly in line with the midline drawn parallel to the long axis of the platform so that the Ax direction represented lateral movements and the Ay direction represented anterior posterior movements. Archers shooted over a standart olympic distance (the distance between the shooting line and the target was 18 meters which is an official competition distance (**Figure 2**)(FITA, 2010).

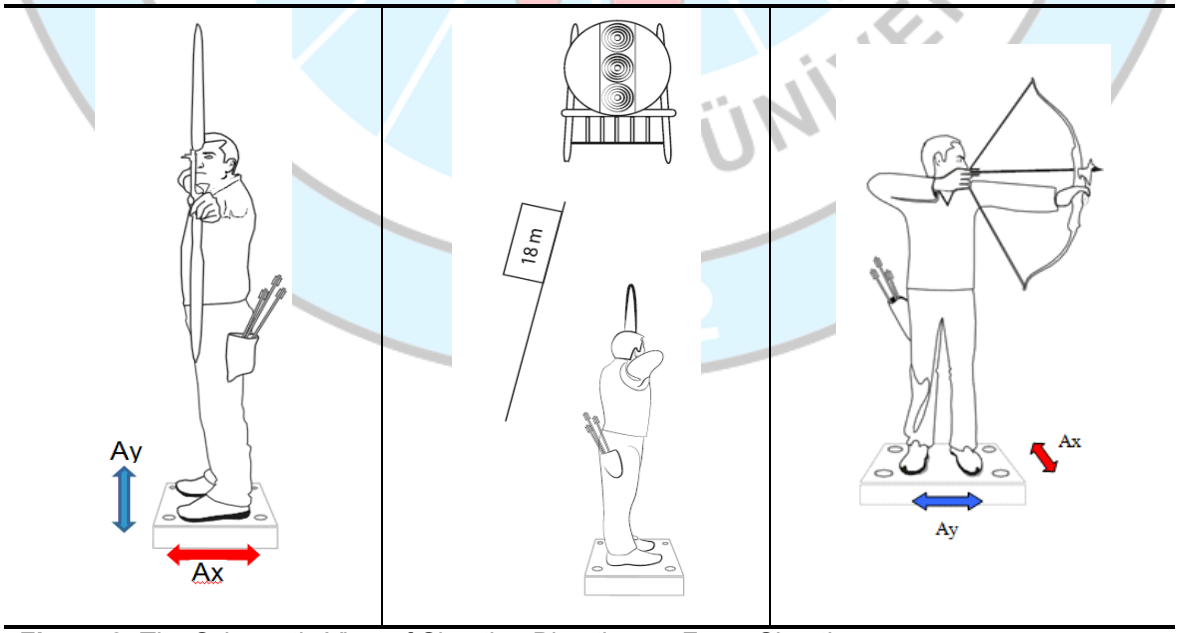
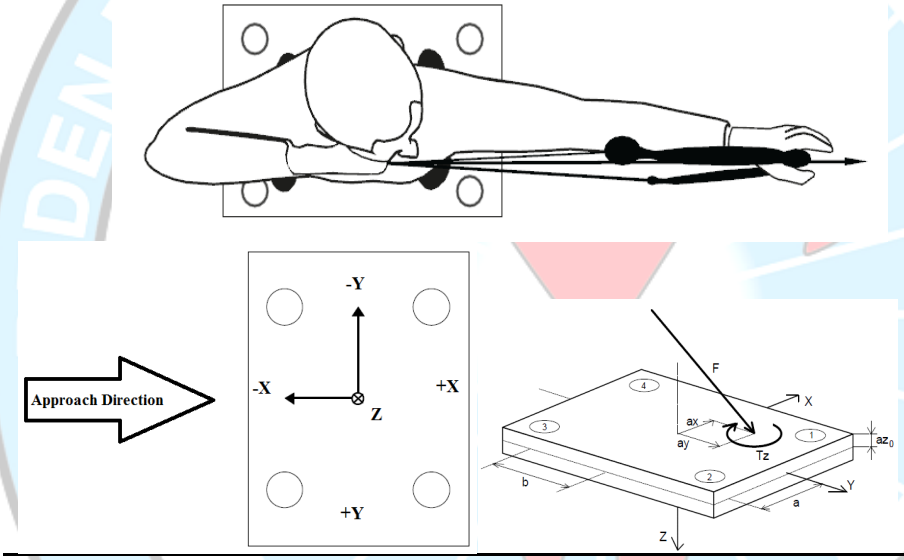


Figure 2: The Schematic View of Shooting Direction on Force Shooting

Experimental Procedure: Data was recorded from a single force platform. Therefore both feet were in contact with the ground, and the net COP lies somewhere between the two feet. All the same target scores were analysed. The position of the each archer feet was then marked and they were told to ensure that this position was kept throughout the recording session. Data collection consisted of one practise session and the archers have shot 12 arrows after familiarization shooting trials.

Statistical Analysis: The COP data was collected using the "Kistler force plate, Germany" operating at 1000 Hz.(**Table 2**) Data was analyzed using "Bioware software, Germany" to calculate the descriptive statistics of the COP data (range and standart deviation). Mean scores were calculated across each participant's 12 shots which was then used to calculate the within group mean (recurve, compound, traditional)(**Table 3)**. Calculated values were exported to Microsoft Excel for further analysis.

Table 2. Force Plate Output Signal- Channel and Description



Output signal	Channel	Description
fx12	1	Force in X-direction measured by sensor 1 + sensor 2
fx34	2	Force in X-direction measured by sensor 3 + sensor 4
fy14	3	Force in Y-direction measured by sensor 1 + sensor 4
fy23	4	Force in Y-direction measured by sensor 2 + sensor 3
fz1 ... fz4	5…8	Force in Z direction measured by sensor 1 ... 4

Table 3. Force plate calculation formulas

Parameter	Calculation	Description
Fx	= fx12 + fx34	Medio-lateral force
Fy	= fy14 + fy23	Anterior-posterior force
Fz	= fz1 + fz2 + fz3 + fz4	Vertical force
Mx	= b * (fz1 + fz2 - fz3 - fz4)	Plate moment about X-axis [3]
My	= a * (-fz1 + fz2 +fz3 - fz4)	Plate moment about Y-axis [3]
Mz	= b * (-fx12 + fx34) + a * (fy14 - fy23)	Plate moment about Z-axis [3]
Mx1	= Mx + Fy*az0	Plate moment about top plate surface [2]
Ax	= -Myı / Fz	X-Coordinate point of applied force (COP) [2]
Ay	= Mxı / Fz	Y-Coordinate point of applied force (COP) [2]

RESULTS

In this study, overall performance was examined into two phases; i.e. release phase and.all shooting. In so doing, the researcher is able to determine the phase that most impacts shooting performance rather than looking at it generally (Balasubramaniam, Riley, and Turvey, 2000; Era et al., 1996; Gautier, Thouvarecq, and Larue, 2008; Mononen et al., 2007).

The participants' shooting performance was measured by their shooting scores from the twelve shots to the 18-meter target. "As Shown in Table 4, The RA groups showed slower medio-lateral (Ay) and anterio-posterior (Ax) directions of the COP displacement than CA and TA groups during releasing phase (**Table 4**). But, the RA groups showed higher medio-lateral (Ay) and anterio-posterior (Ax) directions of the COP displacement than CA and TA groups during all shooting.Furthermore, the COP displacement was also found to be smaller in higher scores than that of lower scores hit on the target among the three groups (mean shooting score of groups respectively: RA= 9.8, CA=9.6, and TA=7.6).

Table 4: Descriptive statistics of the COP

COP Data		RA (cm/s)	TA (cm/s)	CA (cm/s)
		Range±SD	Range±SD	Rande±SD
Ax	Releasing Phase	1,23±0,23	2,52±0,33	1,56±0,38
	All Shootig	4,87±1,42	3,76±0,97	2,73±1,06
Ay	Releasing Phase	1,34±0,14	5,02±0,92	3,43±0,51
	All Shootig	9,84±10,56	5,08±0,23	4,40±2,14

In Figure 3, Recurve Archery Group's Mean COP from 18 m distance (mean COP of 5 x 12 arrow shots), In Figure 4,: Compound Archery Group's Mean COP from 18 m distance (mean COP of 4 x 12 arrow shots) and Figure 5 Traditional Archery Group's Mean COP from 18 m distance (mean COP of 5 x 12 arrow shots) are shown.

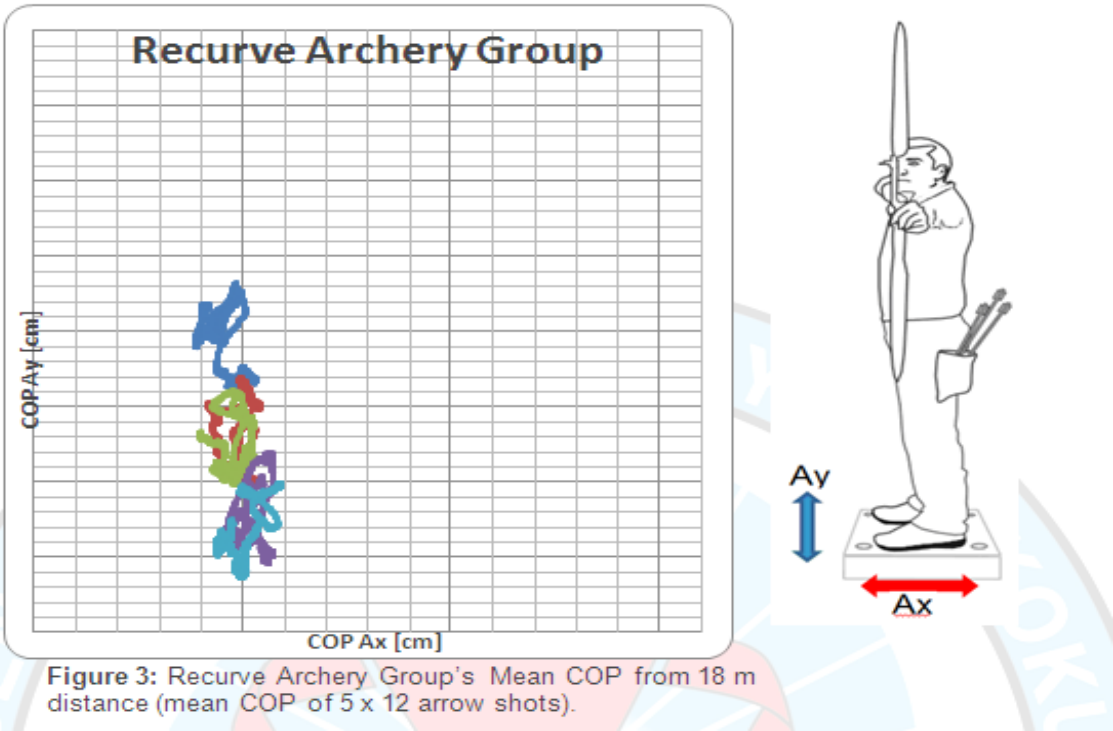


Figure 3: Recurve Archery Group's Mean COP from 18 m distance (mean COP of 5 x 12 arrow shots).

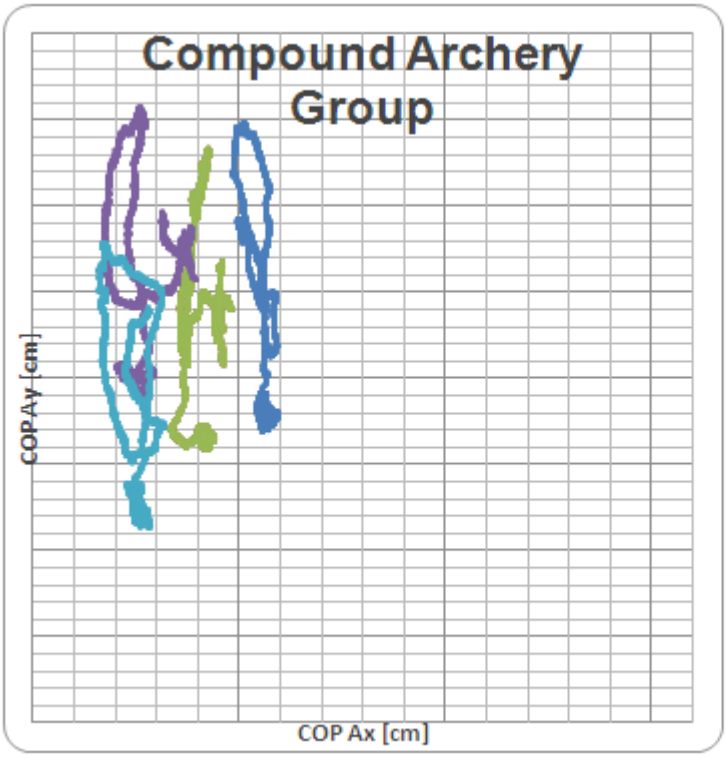


Figure 4: Compound Archery Group's Mean COP from 18 m distance. (mean COP of 4 x 12 arrow shots).

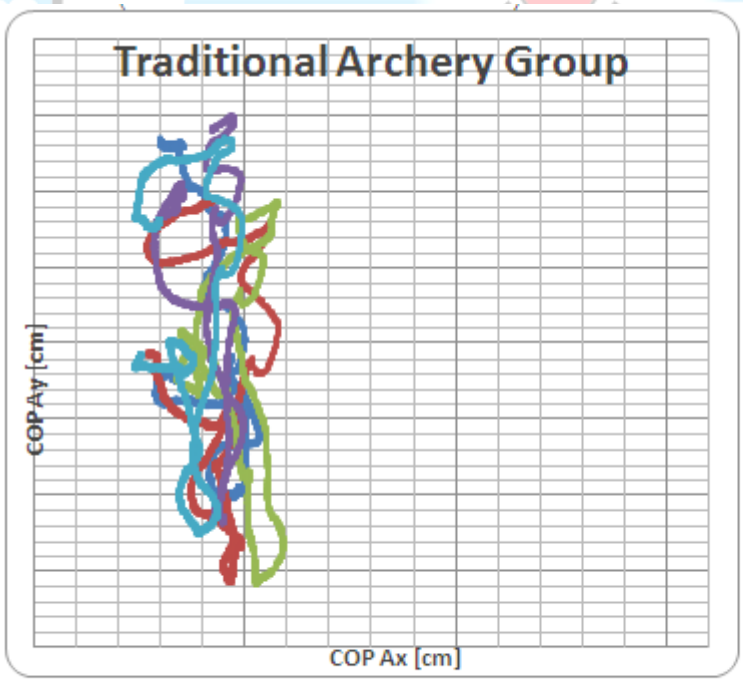


Figure 5: Traditional Archery Group's Mean COP from 18 m distance. (mean COP of 5 x 12 arrow shots).

DISCUSSION AND CONCLUSION

In archery, for example, once the archer has aimed and fixed the posture of the arms, the fluctuations of the body must be preserved in the alignment of the arrow with the target, and the centre of gravity

within the base of support (Ertan and et al.2011; Balasubramaniam and et al. 2000).The purpose of this study was to examine differences in balance abilities during Recurve, Compound and Traditional Turkish Archery.

On qualitative analysis of the COP displacement, and if constraining the level of COP displacement over the shot is considered to be a measure of balance, then archers using the recursive bow displayed the greatest balance control during releasing phase. The second smallest displacement was displayed by the compound group who had some assistive devices attached to the bow. The highest greatest COP displacement was observed in the traditional group, often referred to as bare archery due to the lack of supporting equipment.

In our study, the COP displacement was also found to be smaller in higher scores than that of lower scores hit on the target among the three groups (mean shooting score of groups respectively: RA= 9.8, CA=9.6, and TA=7.6). Postural control is related to skill level for archers, with the more proficient archers displaying greater postural control ability just before arrow shot (Hrysomallis. 2011).

It is worth noting that some of the observed differences may be due to the differences in the length of the bows used by each group. The length of the recurve bow is higher than both the compound and the traditional bows. When the length of the bow decreases, the archer may feel more unbalanced therefore increases the postural sway range. Furthermore, the additional equipment located on a recurve bow may account for these differences.

It can be derived from these results that the recurve archers in this sample displayed a lower COP displacement because of equipment differences when compared with the ranges of the compound and traditional groups. The three different archery categories require different equipment. Therefore in order to decrease COP sway in recurve and compound archery trainers should be focused on balance training. This training could be organised with visual feedback during shooting. However traditional archery technique has different characteristic than the other recurve and compound archery technique. The traditional archery, on the other hand, shoots are performed instinctively; the bow can be held at any angle (called canting), and shooters brain makes the calculations as to what angle to hold the bow in order to find mark. Therefore proprioceptive training included balance from different distances, angle and height could be recommended in order to increase shooting performance.

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