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ORIGINAL ARTICLE

THE ASSESSMENT OF POSTURAL CONTROL MECHANISMS IN THREE ARCHERY DISCIPLINES: A PRELIMINARY STUDY

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 identify the effect of the sway of centre of pressure (COP) with eyes open (EO), eyes closed (EC), dominant and non-dominant eyes open during quiet stance in three Archery disciplines. Fifteen archers (Group I: The Recurve Archery (RA): n=5, Group II: Compound Archery (CA): n=5, Group III: Traditional Archery (TA): n=5) participated voluntary in the study. An 9281EA BioKistler Force Plate system was used to obtain objective measurements of balance in medio-lateral (Ay) and anterio-posterior (Ax) directions of the sway of COP during the trials. As a result, sway of COP of CA group was smaller than the RA and TA group. Compound archers have better static balance ability than the other groups during quiet stance. Therefore, different archery disciplines, equipment, muscular strategies and skill have some effect on postural control performance measurements.

Keywords: Force Plate, center of pressure, balance, visual skills

INTRODUCTION

Postural control is a complex motor skill. which needs interaction of afferent information from the visual. vestibular, and proprioceptive systems (Hrysomallis. 2011; Park et al.. 2011). Visual sense provides information about the environmental form, hazardous situation, distance and ground condition on which movement occurs (Umphred. 2001). Sport training enhances the ability to use somatosensory and otolithic information, which improves postural capabilities. However, postural changes are different according to the sport practiced. Archery is a good example of postural control-required sport to achieve high scores. It is described as a static sport requiring fine movement control, proper endurance and strength of the upper body and balance ability. Dornan et al. (1978) reports that visual sensory ability takes greatest influence on the body posture and balance in the static state. 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). 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). 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. 3-D archery). 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. In addition, while the recurve bow has a piece of plastic round which has adjustable metal plates to provide aiming, the compound bow includes a water balance eye lens (Figure 1). This lens provides the athlete the opportunity to aim a millimeter.

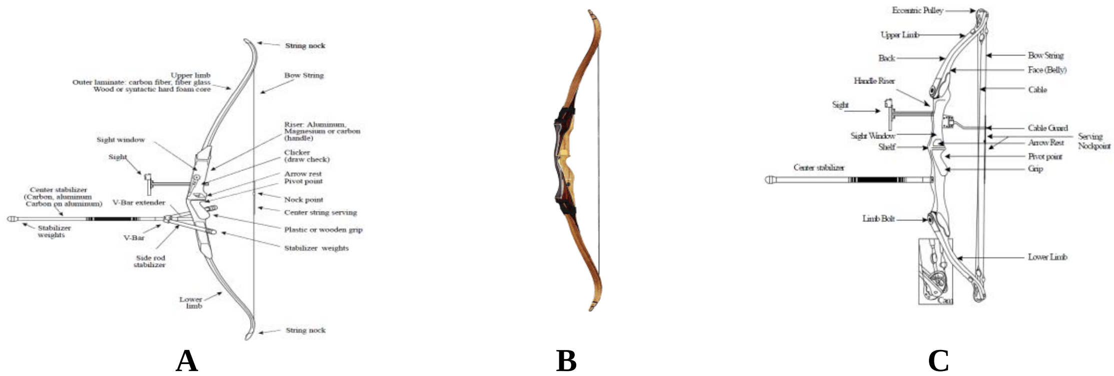


Figure 1: Bow designs of (A) Recurve Bow (FITA) (2010), (B) Traditional Bow (Fadala, 2011) and (C) Compound Bow (FITA) (2010).

The earlier studies have shown that visual response time and eye-body coordination may be the most important skills in archery (Strydomvand Ferreira. 2010; Carlson. 1984). This skill is involved in the ability of the athlete to adjust his/her balance in response to a visual stimulus (Loran and MacEwan. 1995). Mason and Pelgrim (1986) concluded that the accuracy in archery is related to an archer's movement of his/her centre of pressure on the ground just before releasing the arrow. The results indicated that visual stabilization may effects archers postural control mechanism. So, the purpose of this study was to identify the effect of the COP displacement with eyes open (EO), eyes closed (EC), dominant and non-dominant eyes open during quiet stance in three Archery disciplines.

METHODS

Three groups, (i) recurve archers (n=5. FITA score = 1211±26.2) , (ii) compound (n=5. 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. Descriptive statistics are summarized in Table 1, for all groups. All participants were injury free at the time of testing and none reported a previous injury history to their upper or lower limbs.

Table 1: Descriptive statistics of archers

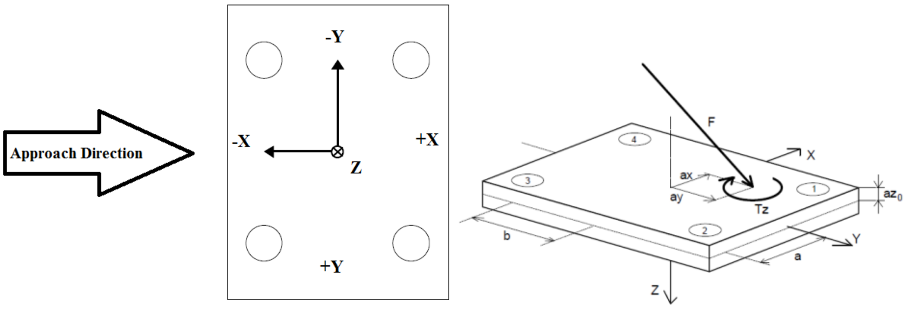
Archery Groups (n)	Athletic History (years) mean±SD	Age (years) mean±SD	Height (cm) mean±SD	Body Mass (kg) mean±SD	Dominant Eyes right	Dominant Eyes left	Draw and Bow Weight Lbs – kg
Group I							
RA (n=5)	7.83±1.15	26 ± 1.5	175.0 ± 6.1	75.4 ± 4.5	right	-	42 – 2.5
Group II							
CA (n=5)	7.36±1.28	22.2 ± 1.8	182.0±5.3	67.9 ± 5.6	right	-	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

COP excursion during quiet stance was measured according to four conditions: Condition 1: eyes open, Condition 2: eyes closed, Condition 3: dominant eye open and Condition 4: non-dominant eye open (Figure 1). To evaluate postural control ability, objective measurements of balance in medio-lateral (Ay) and anterio-posterior (Ax) directions of the COP were used during the trials. 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. During eyes open tests, the subjects were instructed to fix their eyes on a point in front of them. Each subject stood in the standard Romberg position (feet together) on a 9281EA BioKistler Force Platform for 30 seconds. Each subject completed a trial to get acquainted with the measurement conditions. Each test was performed three times with a rest periods of 60 sec between each trial.

The COP data was collected using the “Kistler force plate. Switzerland” operating at 1000 Hz. Data was analyzed using “Bioware software. Switzerland” to calculate the discriptive statistics of the COP data (All data are expressed as mean ± SD.).

Table 2: Force plate calculation formulas



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

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	= -My1 / Fz	X-coordinate point of applied force (COP) [2)]
Ay	= Mx1 / Fz	Y-coordinate point of applied force (COP) [2)]

Condition 1: eyes open

Condition 2: eyes closed

Condition 3: dominant eye open

Condition 4: non-dominant eye open

Figure 1. COP excursion during quiet stance (four conditions)

RESULTS

The comparison of the sense of balance between eyes open, eyes closed, dominant eye open and non dominant eye open in static test conditions: the COP sway of CA group was smaller than the RA and TA group. Compound archers have better static balance ability than the other groups. Compound archers have better static balance ability than the other groups during quiet stance.

According to results the COP sway of Compound Archery (CA) group in Anterior-Posterior and Medio-Lateral directions has been found as Condition 1: -0.492 ± 0.4345 cm/s; 0.3072 ± 0.1763 cm/s, Condition 2: -0.112 ± 0.5846 cm/s; 0.5566 ± 0.4508 cm/s, Condition 3: -0.156 ± 0.3052 cm/s; -0.843 ± 0.2161 cm/s, Condition 4: -0.299±0.2576 cm/s; -0.251± 0.1887 cm/s respectively.

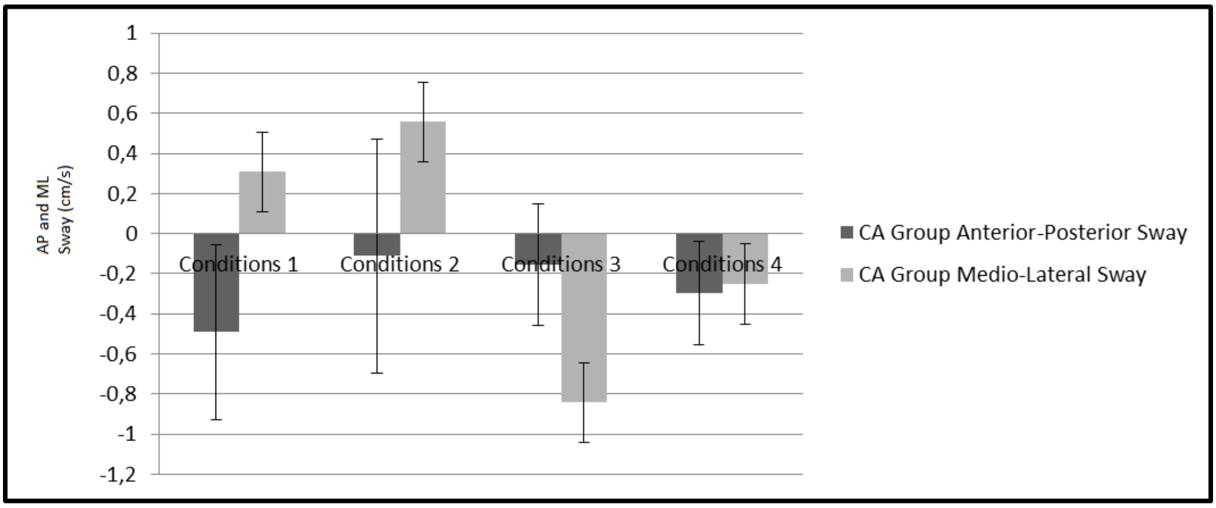


Figure 2. The Sway in anterio-posterior (Ax) and medio-lateral (Ay) directions of Compound Archery group according to four conditions during in quiet stance (expressed as a percentage of body weight. BW).

According to results the COP sway of Recurve Archery (RA) group in Anterior-Posterior and Medio-Lateral directions has been found as Condition 1: 0.1824 ± 0.501 cm/s; -1.595 ± 0.0193 cm/s, Condition 2: -0.686 ± 1.0715 cm/s; -2.587 ± 0.5362 cm/s, Condition 3: -2.939 ± 0.4632 cm/s; -2.202 ± 0.1618 cm/s, Condition 4: -3.900 ± 0.494 cm/s; -1.433 ± 0.166 cm/s respectively.

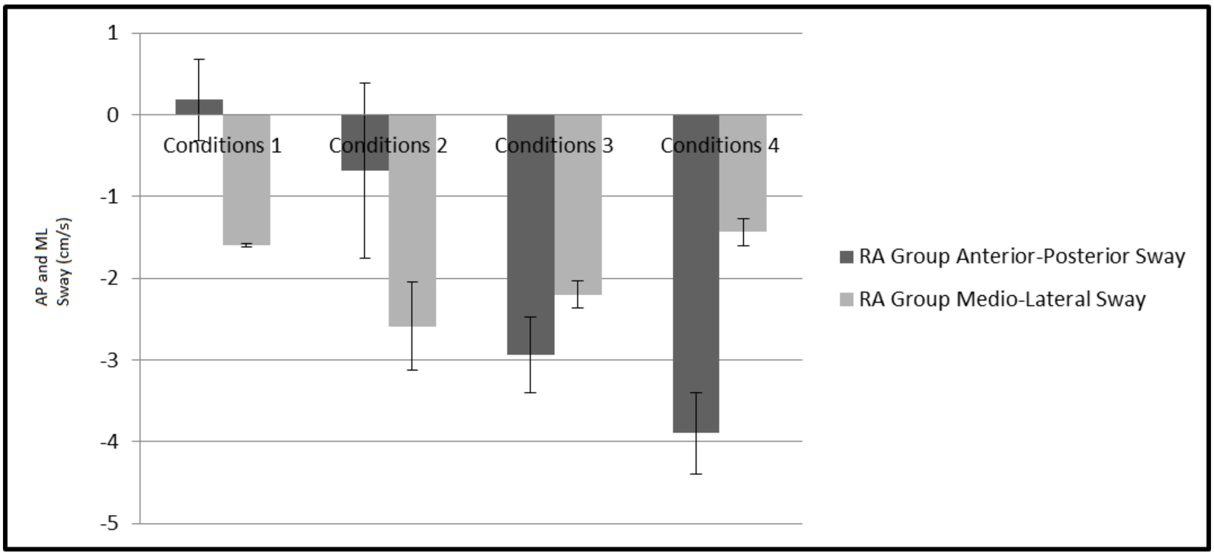


Figure 3. The Sway in anterio-posterior (Ax) and medio-lateral (Ay) directions of Recurve Archery group according to four conditions during in quiet stance (expressed as a percentage of body weight. BW).

According to results the COP sway of Traditional Archery (TA) group in Anterior-Posterior and Medio-Lateral directions has been found as Condition 1: -2.891 ± 0.0824 cm/s; 0.509 ± 0.6281 cm/s, Condition 2: -2.854 ± 0.7985 cm/s; 0.5796 ± 0.4801 cm/s respectively.

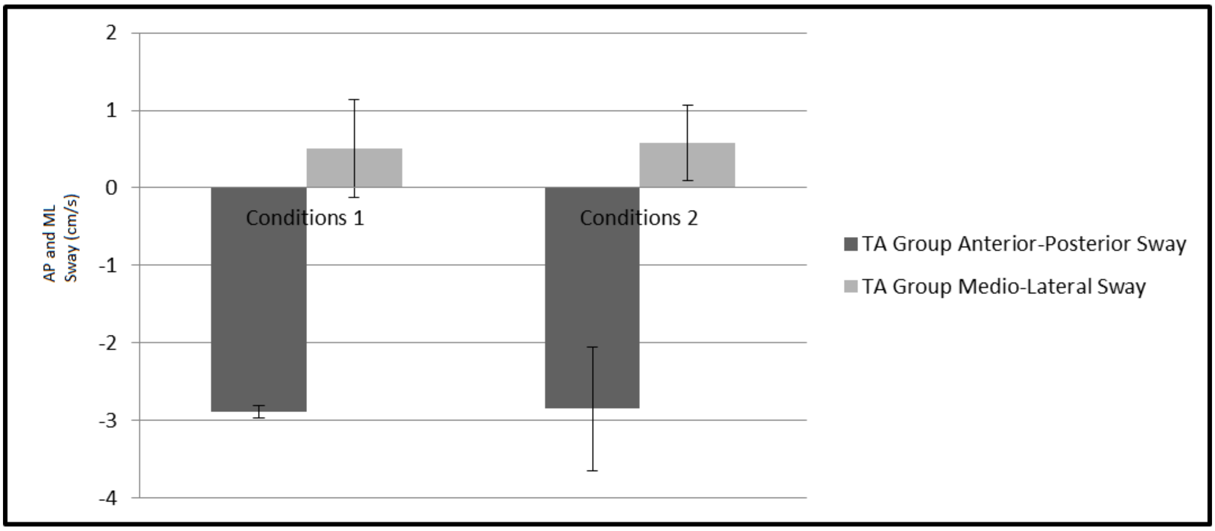


Figure4. The Sway in anterio-posterior (Ax) and medio-lateral (Ay) directions of Traditional Archery group according to two conditions during in quiet stance (expressed as a percentage of body weight. BW).

DISCUSSION

The International Archery Federation (FITA) classifies archery into two major categories: (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, 3-

D archery). Variables such as bow designs and shooting technique vary across these classifications. For instance, (1) while the recurve bow has a piece of plastic round, which has adjustable metal plates to provide aiming, the compound bow includes a water balance eye lens which provides the athlete the opportunity to aim a millimeter. In contrast, traditional bow do not include any form of assistive devices to aim on the target. (2) According to archers who participated to the current study, their draw and bow weights for RA (42 Lbs,-2.5kg), for CA (55 Lbs.-3.5 kg), for TA (53 Lbs.-0.5kg) have been measured respectively. As described above, the draw weights differs according types of bow. However, the draw weight decreases about 50% due to lever-effect mechanism in the compound bow, while the draw weight increases at the end of the draw the in the other bow types (RA and TA). (3) Stability during shooting changes according to types of archery techniques. While the archers use stabile shooting techniques during RA and CA, TA archers use unstable techniques towards the target.

According to the information given above about bow designs and shooting technique vary across archery classifications, the results which has been gathered in the current study can be discussed around vision skill and balance control (body sway) as (1) The previous research results indicated that certain visual skills play a more important role in archery (Carlson. 1984). According to Gardner and Sherman (1995), visual acuity, eye-hand coordination, visual adjustability and central-peripheral awareness are important visual skills in archery. In the current study the less sway occured in the CA and they always perform regular aiming training with lens on the compound bow to aim on the target in millimetres. However, the RA technique is performed with metal plates and this not cause millimetric focusing to target like CA. TA technique is not performed with assistive devices, so visual skill is not used as much as the other archery techniques. This shows that the visual training program develops visual skills related to archery discipline. Therefore, we think that there may be a direct relationship between vision and sporting performance and balance ability, which was tested in the current study. (2) The other important parameter, which has an impact on the balance ability could be equipment differences. The RA and CA have specific equipment comprises; long and short rods, v-bars and doinkers as example, and attached to the recurve and compound bow are equipment facilitating bow stabilization and vibration dampening. TA bow do not include any equipment for stabilization and vibration dampening. If it is summarised why both A-P and M- L sway of COP in the traditional archers is the highest of all. The reasons for this may be that (1) traditional archers do not use sight to aim on the target. (2) traditional archers use more two distinct muscular strategies than recurve and compound archers. Because, body sway in side-by-side feet position is believed to be controlled by two distinct muscular strategies; ankle for antero-posterior "A-P" sway, and hip for medial–lateral "M-L" sway (Day, Steiger, Thompson, & Marsden. 1993; Gatev, Thomas, Kepple & Hallett, 1999; Winter, Patla, Ishac, & Gage. 2003; Winter, Prince, Frank, Powell, & Zabjek, 1996).

In summary, the goal of this study was to compare the open and closed eyes static balance ability among three Archery disciplines. Based on the findings of this study, it is suggested that different archery technique. Equipment, muscular strategies, and skill have some effect on postural control performance measurements. It can be concluded that the stability plays an important role in archery performance. However, further studies using greater sample sizes to evaluate the visual skills on a more extensive level. The question of whether muscular strategies training on of these visual skills may improve the performance of the athletes remains unanswered and could lead to further studies.

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