Research Article

Journal of Sports Science and Physical Therapy

Postural and Isokinetic Evaluation of Tunisian Military Shooters

Ksiabi Imene*, El May Wafa, Maaoui Rim, Bejaoui Amira, RahaliKhachlouf Hajer

Department of Physical and Rehabilitation Medicine, Military Tunis Hospital, Faculty of Medicineof Tunis, Tunisia

***Corresponding author:** Ksibi Imene, Department of Physical and Rehabilitation Medicine, Military Tunis Hospital, Faculty of Medicine of Tunis, Tunisia. Tel: +21698628018; Email: imeneksibibs@yahoo.fr

Citation: Imene K, Wafa EM, Rim M, Amira B, Hajer RK (2018) Postural and Isokinetic Evaluation of Tunisian Military Shooters. J Sports Sci Physical Ther JSSPT-100001.

Received Date: 05 August, 201; **Accepted Date:** 05 August, 2018; **Published Date:** 23 August, 2018

Abstract

Introduction: Among all shooting modalities, air pistol is one where the static balance plays a crucial role. Air pistol shooting requires precision and accuracy. Although many are the factors that influence performance in air pistol shooting, the ability to stabilize the gun seems to be the most important one. Military shooters are a particular population of athletes sought in extreme conditions.

In this study, we proposed to conduct a postural and isokinetic assessment of military shooters to better approach the stabilometric parameters and muscle strength that characterize them.

Methods: Our study was a prospective cross-sectional study conducted in the Physical and rehabilitation Medicine Department in the Military Tunis Hospital during May 2018. We recruited military athletes practicing air pistol shooting. All athletes had both a clinical and instrumental evaluation of their static posture on a flat platform (WinpostureR) and an isokinetic evaluation (BIODEXR) of the hamstrings and the quadriceps in three velocities 60°/s, 180°/s and 300°/s.

Results: 10 militaryshooterswereenrolled. The meanage was 27.5 ± 4.9 years, ranging from 22-38 years. All athleteswereright-handed. On clinicalevaluation, lumbarlordosis was foundtobeexagerated. The spinal flexibilitywas found proper in mostathletes. Instrumental assessment of the balance on a static platform (Winposture®) found a decreased surface in nine shooters eyes closed and a decrease in the anteroposterior sway of the center of pressure in 8 shooters. On the isokinetic evaluation, a statistic difference was found between the dominant and the non-dominant side in the flexors at 180°/sec and 300°/sec.

Conclusion: Postural control in athlete shooters is a crucial factor conditioning the performance of the athlete. The nature and the specificities of the sport can also influence the postural profile of the athlete. Isokinetic evaluation allows appreciating the knee muscles strength, in order to detect a possible imbalance that can lead to injury.

Keywords: Isokinetic; Instrumental Evaluation; Postural Profile; Shooters

Introduction

Postural stability can be defined as the ability of an individual to maintain their center of gravity within the base of support. Postural stability can be static or dynamic. Many complex physiologic and neurological processes control postural stability. Maintenance of posture relies on proprioceptive input and effective muscular response. Once processed in the CNS, efferent information is sent to peripheral muscles. Muscle strength is an important factor involved in maintaining balance, especially muscles of the lower limbs. In fact, all body movements are produced via contraction of skeletal muscles. So that, lower limb muscles are particularly important in allowing the body to maintain postural stability since they work to keep the center of gravity within the base of support. Postural stability and muscle strength is important in sportsman especially in elite shooters. In fact, among all the modalities of shooting, the static component plays a crucial role. Pistol or rifle shooting is a discipline that requires "Accuracy and exactitude". It requires exceptional concentration and a strong mental approach. The slightest uncontrolled movement can lead to failure. Although many factors may influence the performance, the shooter's ability to stabilize the rifle appears to be the most important factor [1,2].

There appears to be a consensus that the ability to stabilize the gun and hence performance is controlled by the center of pressure (COP) movement [3-5].Significant correlations were noted between performance and CPC movements in early shooters [6].Elite shooters have been found to produce smaller body sway amplitudes, as indicated by COP movement, than the general population [7] and non-elite shooters [8,9], with elite shooters exhibiting COP ranges of less than 1 mm in the last 2 to 4 seconds before the shot event [9].COP movements are measured using force platforms. Several variables are used for the measurement of COP movements such as the total surface area of the COP displacement and the maximum distances traveled by the CPC on the x and y axes and the average or maximum speeds on the X and Y axes [10,11].

The main objective of this study was:

- To examine the postural balance of athlete shooters by evaluating the COP movements on a static platform
- To evaluate the strength of Hamstring/ Quadriceps couple using isokinetics, in order to study a possible relationship between postural stability and muscular strength of lower limbs.

Materials and Methods

It was a prospective study conducted at the Physical and Rehabilitation Medicine Department at the Military Tunis Hospital during the month of May 2018.

We included 10 right-handed athlete military shooters(5 males and 5 females). Inclusive criteria were military shooters:

- Aged between 25 and 40 years.
- Practicing alongside their military duties for at least 5 years and participating in national and international competitions.
- Without visual or orthopedic problems.

Atheletes who hasn't been training for the last fifteen days and those with osteo-articular or visual problems were excluded from the study.

The participants had a complete physical evaluation prior to the instrumental evaluation.

Besides the anthropometric data, the outcome measures of the physical examination were:

Postural Profile

Participants were examined standing up, the examination was done on a patient standing, barefoot and undressed.

Using a plumb line, we studied the different spinal curvatures by measuring:

- The cervical arrow at C7 (mm)
- The dorsal arrow at D8 (mm)
- The lumbar arrow at L3 (mm)
- The sacral arrow at S2 (mm).

Spinal Flexibility

Using the fingertip-floor distance and the Schöber index.

Lower Limb Flexibility

Using the heel-bottom distance to evaluate the Rectus Femoris retraction. A distance superior to 15cm implies retraction.The popliteal angle was used to assess the hamstrings retraction.An angle superior to 0 impliesretraction.

PodiatryExamination

We have completed the clinical examination of our candidates by a static examination of the feet on a plexiglas tangential light podoscope in search of a possible anomaly of the footprints type pes cavus or pes planus feet that can interfere with their balance.

The outcome measures of the instrumental evaluation were:

Postural Evaluation on a Static Platform

We proceeded to a postural evaluation on a Winposture®static platform(Photo N°1). It is an ultra-thin, 16-bit electronic platform that allows reliable recordings at 40 Hertz. All miniaturized signal processing electronics are integrated into the thickness of the platform. The evaluation was done with the athletes standing on the platform, facing a target at eye level, with the feet in the reference position indicated on the platform and then simulating the shooting position. It was made witheyes open (OE) then Closed Eyes (CE) for each position. Postural balance was evaluated in terms of Surface of the confidence ellipse (Surface), anteroposterior (average Y) and mediolateral (average X) sway velocity of the movement of the COP and Romberg's quotient (QRBG).

Isokinetic Measurements

The isokinetic evaluation of the muscle knees was carried out on a BIODEX isokinetic machine (Photo N°2). The participants were installed following the manufacturer's recommendations in order to ensure better reproducibility of the measurements. Effective strapping was performed on the trunk and thighs to limit the compensations. The subjects were asked to perform movement of flexion and extension of the knees at three different velocities: 60°/s, 180°/s and 300°/s. We measured the Peak Torque (PT), the peak torque normalised to body mass (PT/Body mass), the functional hamstring to quadriceps ratio (H/Q ratio) and the average power (Pow).Isokinetic excentric evaluation could not be done because of lack of preexisting program in the machine.

The dominant side was chosen according to the laterality of the candidate.

Statistical Analysis

The statistical analysis of the data was done by the software SPSS 17. Quantitative variables were analysed by their means ± Standard Error (ES).

Ethic Conflict

The consent of the candidates was obtained to participate to the study.

Results

Table 1 showsthe anthropometric characteristics of the athletes.

	Minimum	Maximum	Mean±SD
Age (years)	22	38	27.5±4.9
Weight (Kg)	56	91	71.7±11.3
Height (m)	1.61	1.82	1.71±0.07
BMI (Kg/m²)	19.6	29.4	24.5±3.3

Table 1: Anthropometric characteristics of the participants.

The average cervical, lumbar and sacral arrows were 42±11.8mm, 48.5±13.5mm and 25±10.8mm, respectively. We have noted a tendency towards lumbar hyperlordosis. The mean Schöber index was 10+5.9cm and the average fingertip-floor distance was 4.2±2.1cm. The average popliteal angle was 20°±15° and the average heel-bottom distance was 14±3cm.five athletes had normal footprint on the Podiatry examination, 4 had per cavus feet and one had per planus feet.

		Minimum	Maximum	Mean	SD
Standard position	**Surface**	**6.5**	**103.7**	**45.8**	**29.8**
	Average X	-24.3	11.4	-5.1	10
	Average Y	-79.6	-27.8	-62.8	15
	QRBG	62	131	93.7	24.8
Shooting position	Surface	19.8	70	46.9	15.5
	Average X	-21.2	10.9	-3.6	10.5
	Average Y	-84.6	-51.1	-67.2	10.7
	QRBG	80	244	139.7	47.9

Table 2: results from the postural evaluation on a static platform.

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- The surface: comparing to normalized parameters calculated for general population, a decreased surface was noted in 4 athletes OE and 9 CE in the standard position. A decreased surface was observed with 2 athletes OE and 9 CE while simulating the shooting position.
- Mediolateral sway velocity of the COP (average X): we observed a decrease in mediolateral sway velocity with 3 athletes OE and 2 CE in the standard position. In the shooting position, the average X was decrease in 2 athletes OE and CE and was increased in one athlete CE.
- Anteroposterior sway velocity of the COP (average Y): a decrease in anteroposterior sway velocity of the COP was observed in 6 athletes OE and 8 CE in the standard position. In the shooting position, the average Y was decreased in 8 athletes OE and CE.
- Romberg's quotient (QRBG): in the standard position, 2 athletes had a QRBG equal to 100and 5 had a decreased QRBG. While simulating the shooting position, 2 athletes had a QRBG equal to 100 and one had a decreased QRBG.

Isokinetic Evaluation

The collected data from the isokinetic evaluation is shown in table 3.

	EXTENSION 60°/ SEC		FLEXION 60°/ SEC		EXTENSION 180°/SEC		FLEXION 180°/ SEC		EXTENSION 300°/SEC		FLEXION 300°/ SEC	
	Right	**Left**	**Right**	**Left**	**Right**	**Left**	**Right**	**Left**	**Right**	**Left**	**Right**	**Left**
PT/Body mass	255±58	252±59	152±38	140±27	155±33	151±33	104±23	96±23	110±23	104±27	91±22	54±15
PT	179±48	175±45	107±35	98±24	109±29	106±27	74±24	68±22	77±20	61±25	75±43	76±15
Pow	113±32	102±35	72±27	68±19	187±55	174±46	124±51	119±45	178±46	163±47	118±56	104±45
H/Q ratio	59±9	56±9			67±9	63±7			82±12	75±11		

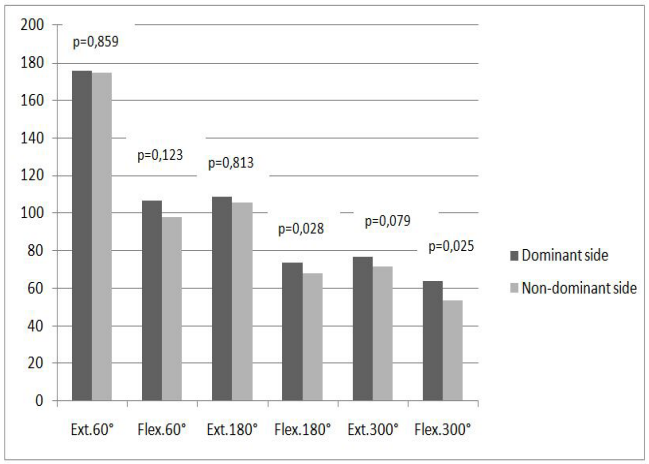

Figure 1: Comparison of the peak torque between dominant and non-dominant side.

Discussion

Our study allowed an objective and quantitative evaluation of postural profile and isokinetic evaluation among tunisian military shooters.

Instrumental assessment of the balance noted a decreased surface and a decrease in the anteroposterior sway of the center of pressure in the majority of the shooters. On the isokinetic evaluation, a statistic difference was found between the dominant and the non-dominant side in the flexors at 180°/sec and 300°/sec.

In most of our participants, we have noted a tendency towards lumbar hyperlordosis. This tendency to rear projection is explained by the posture adopted by the athlete during the shooting. The shooter with a firm grip on his gun is forced to lean slightly backward for better stability. The maintenance of a standing position during bipodal support is a binding task. The sensory information of posture and its changes are numerous. The main sources of this information are vestibular, visual and proprioceptive inputs. The contribution of each entry varies according to a specific postural training. In many sports, the role of static balance is important. This balance is crucial in shooting where even the smallest changes in posture can influence performance. The surface was diminished in the majority of athletes thus testifying of a less oscillation of the COP. In the upright position, the COP sway is found to be considerably less important among trained shooters compared to the control subjects[6].Many studies investigated the physical conditions that determine instability or tremor of the shooter and the ways in which they can be minimized to improve the accuracy of the shot [12]. Thus, for a better stabilization of the firearm, an optimal control of the body movements is necessary.

There are numerous references to the effects of postural balance [6,1]and the weapon stability while shooting [3,4,13-16]. Ball et al.[3] found that postural balance affects rifle stability. Postural balance and rifle stability tend to be different in inexperienced shooters with greater postural balance perturbations causing larger gun movements [1]. Experienced shooters have greater ability to keep their rifles more stable during the aiming period compared to novices [15,17,18] as their body oscillations are much smaller[14]. Experienced shooters rely less on visual input to stabilize their posture. Viitasalo et al.[9] showed that the COP movement in the last 2-4 seconds before firing is less than 1 mm. When shooting, athletes must remain as steady as possible during their performance. Experienced shooters were found to have less body sway compared to novices [6,19]. Some researchers [6] have studied the association between the balance capabilities and the shooting performance. They found that lesser body sway is a crucial determinant to a great performance.For most sports, there is a demand for the lower limbs, especially the knees, because of their mobility. A muscle imbalance in this joint will affect performance and expose the athlete to the risk of muscle damage. This notion applies particularly to shooting where stable knees are necessary to ensure a better postural balance and especially to minimize the oscillations of the COP of the body

weight. Several authors have stressed the need to perform isokinetic tests before starting the season [20]. This evaluation allows an objective and quantitative muscular evaluation and detects the possible muscular imbalance around the studied articulation.

Yeung et al.[21] showed, after a 12-month follow-up of high-level sprint runners, that a ratio inferior to 0.6 measured at 180°/sec was considered as a risk factor for muscle injury and tendinous rupture. Our athletes had a ratio more than 0.6 to 180°/ sec, which indicates a strong quadriceps in order to maintain an optimal stability of the knees allowing better control of the oscillation of the COP.

The study of the agonist / antagonist ratio is therefore important in order to evaluate static and dynamic stability of the knee and to detect athletes at high risk of hamstring injuries [22].

Conclusion

Postural control in athlete shooters is a crucial factor conditioning the performance of the athlete. The nature and the specificities of the sport can also influence the postural profile of the athlete. Identification of Postural and muscle profile of shooters allows a better understanding of mechanisms of stability among this population and allows introducing the concept of rehabilitation in cases of instability. Isokinetic evaluation allows appreciating the knee muscles strength, in order to detect a possible imbalance that can lead to injury.

Conflict of Interest: None.

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