Once processed in the CNS, efferent information is sent to peripheral neurological processes controlling postural stability. Maintenance of stability can be static or dynamic. Many complex physiologic factors influence the postural profile of the athlete. Isokinetic evaluation allows appreciating the knee muscles specificities of the sport can also influence the postural profile of the athlete. The nature and the 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 (Winposture®) and an isokinetic evaluation (BIODEX®) of the hamstrings and the quadriceps in three velocities 60°/s, 180°/s and 300°/s.

Results: 10 military shooters were enrolled. The mean age was 27.5 ± 4.9 years, ranging from 22-38 years. All athletes were right-handed. On clinical evaluation, lumbarlordosis was found to be exaggerated. The spinal flexibility was found proper in most athletes. 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 statistical 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 neurophysiologic 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.
Athletes who hadn’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 implies retraction.

### Podiatry Examination

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 with eyes 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 excursion 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 shows the anthropometric characteristics of the athletes.

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

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

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>6.5</td>
<td>103.7</td>
<td>45.8</td>
</tr>
<tr>
<td>Average X</td>
<td>-24.3</td>
<td>11.4</td>
<td>-5.1</td>
</tr>
<tr>
<td>Average Y</td>
<td>-79.6</td>
<td>-27.8</td>
<td>-62.8</td>
</tr>
<tr>
<td>QRBG</td>
<td>62</td>
<td>131</td>
<td>93.7</td>
</tr>
<tr>
<td>Surface</td>
<td>19.8</td>
<td>70</td>
<td>46.9</td>
</tr>
<tr>
<td>Average X</td>
<td>-21.2</td>
<td>10.9</td>
<td>-3.6</td>
</tr>
<tr>
<td>Average Y</td>
<td>-84.6</td>
<td>-51.1</td>
<td>-67.2</td>
</tr>
<tr>
<td>QRBG</td>
<td>80</td>
<td>244</td>
<td>139.7</td>
</tr>
</tbody>
</table>
Comparison of the peak torque between dominant and non-dominant side.

<table>
<thead>
<tr>
<th></th>
<th>EXTENSION 60°/SEC</th>
<th>FLEXION 60°/SEC</th>
<th>EXTENSION 180°/SEC</th>
<th>FLEXION 180°/SEC</th>
<th>EXTENSION 300°/SEC</th>
<th>FLEXION 300°/SEC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Right</td>
<td>Left</td>
<td>Right</td>
<td>Left</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>PT/Body mass</td>
<td>255±58</td>
<td>252±59</td>
<td>152±38</td>
<td>140±27</td>
<td>155±33</td>
<td>151±33</td>
</tr>
<tr>
<td>PT</td>
<td>179±48</td>
<td>175±45</td>
<td>107±35</td>
<td>98±24</td>
<td>109±29</td>
<td>106±27</td>
</tr>
<tr>
<td>Pow</td>
<td>113±32</td>
<td>102±35</td>
<td>72±27</td>
<td>68±19</td>
<td>187±55</td>
<td>174±46</td>
</tr>
<tr>
<td>H/Q ratio</td>
<td>59±9</td>
<td>56±9</td>
<td>67±9</td>
<td>63±7</td>
<td>82±12</td>
<td>75±11</td>
</tr>
</tbody>
</table>

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 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 100 and 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.
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.

References