Evaluation of the effect of an orthoptic exercise through a fencing mask on postural regulation and sporting gesture

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1. Introduction

From a preliminary study, we observed that high-level fencers suffered as much disruption to the posture regulation by the port of a fencing mask as a controlled population who had never practiced this sporting activity. The orthoptic balances revealed significant disorders with the mask around the visual field for the whole group and the convergent fusional capacities for 95% of them.

Porting a mask increased the oscillation surface of the center of pressure in standing standardized station. Fencing developed neuromuscular coordination, especially between the eye and the hand. Reactions are linked to the speed of processing the visual information: the eye precedes the gesture (Berthoz and Petit, 2006). In motion, the eyes anticipate the movement of the feet by 300 ms. During a dynamic activity, it is the vision that initiates and guides the movement. To watch, you have to move the eyes and look in the same direction. This is why Roll et al. (1991) indicates that every musculoskeletal muscle is also oculomotor insofar as it mobilizes the eyes in its environment at the same time as the realized movement.

Oculomotor activity is predominant but it is subject to the quality of the visual apparatus, the accommodation action is associated with the efforts of the oculomotor muscles (Ridel et al., 2004). Extra-ocular signals related to the angle of vergence would also be involved in the control of postural oscillations, and particularly anteroposterior oscillations (Lê, 2008). Thus, the central nervous system would use vision coupled with the oculomotor signals of convergence to reduce anteroposterior oscillations. It is known that coupling oculomotor and neck muscles is strongly involved in postural control (Cornel et al., 2004). The eye and the cervical spine work according to a reflex activity through the vestibule in order to maintain a stable eye (Bove et al., 2009). The coordination between the eye and the hand brought many studies over the years. During discrete punching motion carried out as quickly and precisely as possible, the eye begins to move towards the target before the departure of the hand. The eye reaches the target the hand has stopped moving (Robitaille, 2012).

Based on these observations, we considered working on the oculomotor system in order to try reducing the disturbance of the fencing mask on the postural regulation and improvement a specific gesture of fencing, the lunge.

Our hypothesis was that a specific orthoptic exercise performed through the disturbing element, the mask, could significantly improve some stabilizing parameters and optimizes the precision of the lunge in fencing.

2. Methods

Twenty-two male subjects (20.3 ± 1.1 yrs) participated in our study. All participants were high level fencers (national or international level; 15 h fencing training by week). They all gave their informed consent. Subjects were separated into 2 groups of 11 fencers each: FenO, who performed orthoptic exercises, and FenT, the control group. FenO realized a protocol of 20 min of orthoptic exercises through the fencing mask 3 times per week for 6 weeks. It consisted of series of visual pursuits of a moving target (red tip of 1 cm at the end of a training foil). Ocular saccade protocols are effective on postural control and on the accuracy of sporting gesture thanks to the work of pursuing a target (Clark et al., 2012).

During a lunge exercise with mask for both groups (2 sequences of 20 lunges, 1 per consecutive days), we noted the aiming precision at the numerated target (1 to 5); 1 point/right target. The random vocal demand was executed at 50 bpm. The score was averaged and compared before and after work (assessment of eye/hand coordination).

To evaluate postural control, we used the Fusyo platform (at the sampling frequency of 40 Hz; during 51.2 s, Medicapteurs). The subject was 90 cm from the mark which has been proven to be the best distance to evaluate the visual input (Gagey et al., 1985). Twenty-four recording random protocols were obtained open eyes (OE), closed eyes (CE), OE with mask, CE with mask. We performed two recording sessions for both groups, before the orthoptic work (T0)
and then after 45 days (T45). The measured parameters were the surface (90% of the instantaneous positions of the CoP), length XY of CoP excursions, lengths X and Y (for vision impact evaluation on postural stability), and mean speed displacement of CoP which is a good index of the amount of neuromuscular activity needed to control vertical posture.

### 3. Results and discussion

The first results confirmed the hypothesis of our preliminary study. We used the Mann-Whitney-Wilcoxon test (non-parametric) to assess differences between no- and with-mask, open and closed eyes conditions (all fencers) and between groups (OE).

Stabilometric parameters are increased (p < 0.05) in OE with mask vs. no mask by vision perturbation through wire mesh. The mask does not modify all parameters in CE condition, maybe high level fencers developed an efficient neuromuscular coordination for neck muscles by the added weight on the head (about 3 kg). Table 2 shows postural stability improvement when participants performed the protocol with orthoptic exercises (p > 0.05). The main speed decreases, suggesting a lower energy cost. (Matheron and Kapoula, 2011). This result is in accordance with the results obtained by Rougier and Garin (2006) who showed that vertical and horizontal ocular saccades in a training protocol decrease postural sway. An efficient vergence can be performed postural stability (Kapoula et al., 2016).

The lunge score augmented significantly (from 10 to 14.12, p = 0.01) for FenO, not for FenT (from 11.14 to 11.05, p = 0.62). This technical increase is matched with eye/ hand coordination, in a vergence task. Orthoptic exercises through the mask improve the fencer’s gesture tracking task, in accordance with physical training as proposed by Redondo et al. (2014).

### 4. Conclusions

By sporting excellence implemented by the sports federations, we are regularly asked, as podologist and posturologist, to evaluate the postural abnormalities that can be improved in order to maintain peak performance. We were able to show that by following a protocol of orthoptic exercises carried out wearing the fencing mask 3 times per week for 6 weeks, the visual disturbance is reduced which improves the postural stability and increases the performance of fencing lunge.

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