# Is the kinematic of the trunk during the forehand in tennis still disrupted in women at one year of postpartum?

Racha Doya[a], Antonio Pinti[b], Aurore Bourrelly[a], Samuel Boudet[c] & Eric Watelain[a*]

[a] *Université Lille Nord de France, UVHC, LAMIH, CNRS-UMR 8201, F-59313 Valenciennes ;* [b] *EA 4708, I3MTO, CHRO - 1 rue Porte Madeleine, F-45032 Orléans ;* [c] *UCLille, F-59000 Lille*

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## 1. Introduction

The number of female athletes (♀) has shown significant growth in the recent Olympics. The percentage of ♀ has increased from 18 % in Seoul (1988) and 38 % in Sydney (2000) to 44 % in the London Olympics (2012). It is not so unusual that elite athletes have a child during their high level career. However, throughout pregnancy (P), ♀ cannot continue their training pace as before (Clapp, 2000). These influence their physical capacity and reduce their athletic performance in postpartum (PP) and / or delay the return to a pre-P performance level. In contrast, Beilock *et al.* (2001) show that maintaining a certain level of cardiovascular and muscle strength during P can help athletes to quickly return to competition in PP. Tennis is a sport that significantly solicits the trunk to produce its technical gestures (Ellenbecker 1996). Indeed, to a large extend, the transfer of kinetic energy from the legs to the racket depends on a suitable rotation of the trunk. The trunk is the part 'hinges' in the kinetic chain to develop and transfer the power from the legs to the racket during the strike (Roetert & Groppel 2001). Several studies on pregnant ♀ show that the trunk is the most affected part by the morphological changes during P. This is especially due to a relaxation in articulations ligaments because of the hormonal changing (Clapp *et al.* 1989) but also decreased activity during P. Forehand is the second most common technical gesture in tennis. It requires 'good' trunk rotations for its completion (Johnson, 2006). The angle of trunk rotation in the transverse plane at the end of the preparation phase is quantized to 104° (shoulder line relative to the bottom line of tennis court; Kibele *et al.* 2009).

We hypothesize that a strengthening program centered on the trunk during P could help to quickly return to the initial level of technical performance before P.

## 2. Methods

The population consists of 3 groups of ♀: control (CG, n = 8), without children or P; inactive during P (IG, n = 12) and active during P (AG, n = 6). The 3 groups were homogeneous in terms of performance level, age and weight. AG received a strengthening program centered on the trunk during 12 weeks. The program for the AG is performed between the 24th and 36th week of P. It focuses primarily on the trunk and aims to maintain and develop the main physical qualities. Forehand gesture is quantified using the Vicon Nexus 1.4.114 gestural analysis system. The kinematics of the trunk (thorax angle & back angle in degrees) is measured and exported from Vicon Nexus software for each subject at each trial. The analysis is then performed by phase (preparation, acceleration, ball striking and accompaniment; Morris *et al.* 1989). A nonparametric ANOVA (Kruskal Wallis test) was used for non-normal data and a one-way ANOVA for other data (Statistica 9; © Statsoft). The significance value of $p$ is chosen such as $p \leq 0.025$ (Bonferroni adjustment).

## 3. Results & Discussion

No difference was observed in performance (number of faults or ball placement) between the 3 groups. For each group, the results are shown in terms of mean and standard deviation of the flexion angle of thorax (Figure 1) and back (Figure 2). The AG always has values of chest and the back bending closer to the CG compared to IG (Figure 1 and 2). Then the IG attacks the ball with the trunk more bending forward compared to the other 2 groups (AG and CG). These phases must be performed with the back straight in order to facilitate the rotation of the shoulders to the net (Bahamonde, 2001). The differences between the IG and the other groups (AG & CG) are more evident during acceleration phases IG thorax = 25.8±8.4° ; back = 29.4±5.4°) *versus* (AG thorax = 14.2±13.4° ; back = 19.6±7.4°, CG thorax = 12.8±10.6° ; back = 19.9±6.7°). This result is likely to be related to maintain a strong grip of the racket during the acceleration phase and in the context of a faster strike itself (Bahamonde, 2001). During the accompaniment, Figure 1 and 2 shows that the IG realizes this phase with a more forward pending trunk (thorax = 21.1±9.7° ; back = 24.6±9.2°) compared with (AG & CG) (respectively thorax =11.3±13.6°; back = 16.5±8.3° & thorax = 11.2±8.7°; back = 10.8±6.3°).

* ***Corresponding author:eric.watelain@univ-valenciennes.fr***

This changes in these movements to accompany the ball may be related to the previously perturbation observed in the acceleration phase of the gesture, which is a critical phase for giving speed to the ball. Indeed, the amplitude of the final stage of the arm is associated with the speed acquired by the racket during acceleration (Bahamonde, 2001).

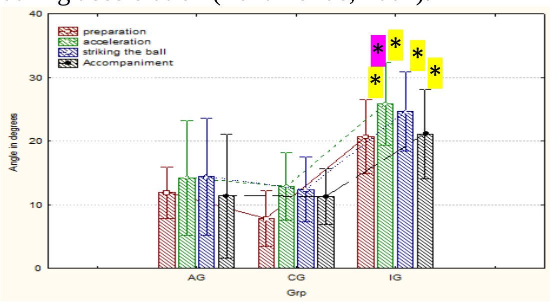


Figure 1: Average angle of flexion / extension of the thorax from the phase of preparation to the phase of accompaniment.

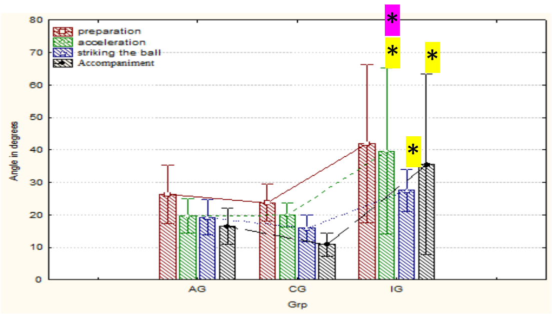


Figure 2: Average angle of flexion / extension of the back from the phase of preparation to the phase of accompaniment.

*Significant difference: *= IG vs CG; *= IG vs AG*

## 4. Conclusion

The results of this study show differences of segment kinematic coordination of the trunk between the groups. Inactive ♀ (IG) during P bend the trunk more during the gesture. Conversely active ♀ (AG) during P are very close to the CG for the parameters studied. A change of technique during the ball attack was observed in IG (attacks the ball with trunks more bent forward). This can be linked to a loss of physical ability required to perform the forehand in tennis, during their sedentary P, may also be bound to a delay in striking the ball. Contrariwise, there is a positive effect of a proposed training program. This work was limited to classified players and with good level of tennis.

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