ISB 2013 BRAZIL
XXIV CONGRESS OF THE INTERNATIONAL SOCIETY OF BIOMECHANICS
XV BRAZILIAN CONGRESS OF BIOMECHANICS

SEGMENTAL COORDINATION DURING KICKING IN SKILLED AND UNSKILLED FOOTBALLERS

[1]Juliana Exel Santana, [2]Joseph Hamill, [3]Paulo Roberto Pereira Santiago and, [1]Sergio Augusto Cunha
[1]College of Physical Education, University of Campinas, Brazil; email: juexels@gmail.com
[2]Department of Kinesiology, University of Massachusetts, Amherst, MA, USA
[3]School of Physical Education and Sport of Ribeirão Preto, University of São Paulo, Brazil

SUMMARY

The aim of this study was to assess hip-knee and knee-ankle coupling coordination of skilled and unskilled in football kicks. A modified vector coding technique was used to evaluate coupling coordination. Cross-correlation was used to assess the similarity between the groups. In the sagittal and transverse planes, hip-knee coordination presented similar patterns for both groups. However, the knee-ankle coupling was different between groups in the transverse plane.

INTRODUCTION

Kicking is a task integral in a football game. This motion demands interaction among several joints and the control of the surrounding muscles to be executed with accuracy in making the ball reach the target successfully. The strategy used by players to overcome the multitude of degrees of freedom in kicking is characterized by the degree of coordination the individual has and, therefore, determines their skill level [3]. Previous studies have shown that less skilled players have greater variability in coordinating lower limb segments than higher skilled athletes [1]. Joint couplings coordination assessment can provide a better understanding about skill differences in goal-directed movements as the kick in football.

Therefore, the aim of this study was to assess lower limb segmental coupling coordination of skilled and unskilled in football kicks. We hypothesized that there would be differences in the coordination patterns between the more and less skilled athletes.

METHODS

Ten male participants were recruited to participate in the present study. They were divided into 2 groups: football skilled practitioners (5 subjects, age 22.8±5.2 years, mass 78.6±4.3 kg, height 1.71±0.04 m) and unskilled (5 subjects, aged 21.6±1.9 years, mass 71.3±6.1 kg, height 1.79±0.05 m). Participants were considered skilled in football if they had more than 10 years of experience and regular practice of at least two times a week. The unskilled had never practiced football before or had practiced kicking a football less than two times a week.

The task consisted of eight trials kicking a stationary ball (Kipsta® F500, size 5), positioned over a marker placed 9 m from a target inside a goal (dimension 1.8 m x 1.3 m) that was suspended 1.1 m from the ground to guide where the kick should be directed.

Kinematic data were obtained from the retro-reflective markers (18 mm diameter) placed on the following anatomical landmarks: anterior superior iliac spine (right and left), sacrum, greater trochanter, lateral and medial femoral epicondyles, fibular condyle, medial and lateral malleolae, calcaneus, cuboid, and the 1st and 5th metatarsal heads. Data were collected with a passive 12 camera OptiTrack Motion Capture System (NaturalPoint®, Oregon, USA), at 250 Hz with an average accuracy of 0.55 mm. Before all analyses, the data were filtered using a 4th order Butterworth digital filter with 12.5 Hz of cut-off frequency.

Cardan angles for the hip, knee and ankle in the rotation sequence z, y' and x'' were calculated from the local coordinate systems of the pelvis, thigh, shank and foot segments. The angles were referenced to the proximal segment coordinate system. The calculated angles in sagittal plane were considered to be flexion/extension while in the transverse plane was considered as internal/external rotation. The coordination analysis was performed using vector coding technique [3,4] for hip/knee coupling and knee/ankle coupling both for the movements of skilled and unskilled in the sagittal and transverse plane. A cross-correlation analysis with a zero lag was applied to evaluate similarity between the skilled and unskilled vector coding time series.

RESULTS AND DISCUSSION

The mean of angular deviations for the hip-knee coupling flexion/extension and internal/external rotation illustrate a similar pattern in joint coordination for both skilled and unskilled participants (Figure 1) showing higher coordination values in the end of kicking cycle. The cross correlation analysis is presented in Table 1.

The cross correlation results indicate that skilled and unskilled practitioners have the essentially the same strategy during the execution of the task in the flexion/extension movement (r = 0.97). However, the results for the knee-ankle coupling (Figure 2) indicate different coordination strategies between groups mainly for the internal/external rotation (r = -0.25). The bottom line of the Figure 2 shows an increase of angular deviation for the skilled group towards the end of the cycle, while the unskilled group maintains a smaller variation through the cycle.

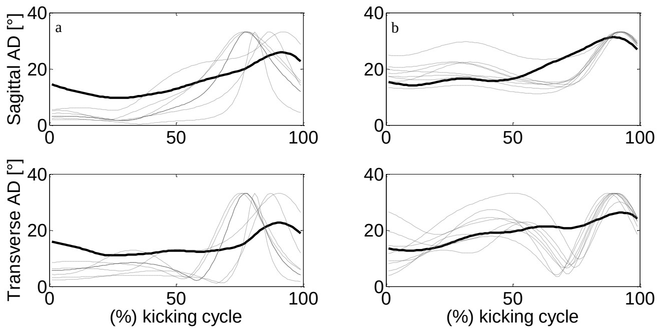

Figure 1. Angular deviations (AD) vs. kicking cycle (0% = touch of the support foot on the ground, 100% = touch of the kicking foot on the ball) in the hip-knee couplings for (a) skilled kicking leg (b) unskilled kicking leg. The rows of panels from top to bottom are: the flexion/extension coupling and the internal/external rotation coupling. The thick solid line is the mean from all trials of 5 subjects. The thin dotted lines are means over eight trials from one subject.

Table 1. Correlation coefficients between skilled and unskilled lower limb couplings during kicking.

Coupling	Movement plane	Value
Hip-knee	Sagittal	0.97
	Transverse	0.66
Knee-ankle	Sagittal	0.50
	Transverse	-0.25

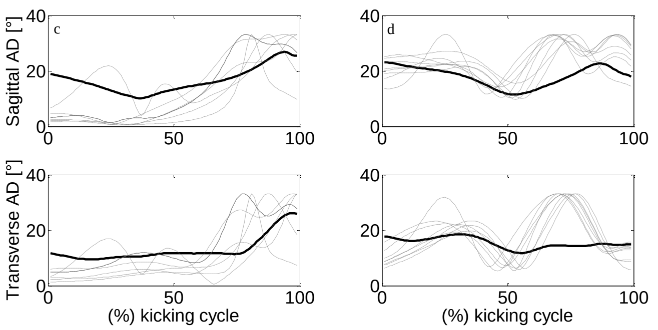

Figure 2. Angular deviations (AD) vs. kicking cycle (0% = touch of the support foot on the ground, 100% = touch of the kicking foot on the ball) in the knee-ankle couplings for (a) skilled kicking leg (b) unskilled kicking leg. The rows of panels from top to bottom are: the flexion/extension coupling and the internal/external rotation coupling. The thick solid line is the mean from all trials of 5 subjects. The thin dotted lines are means over eight trials from one subject.

The knee-ankle coupling in the transverse plane showed strong the differences in the coordination patterns between the groups, a detailed analysis of similarity throughout the whole time series seems to be interesting to verify possible differences in the other movement planes. Figure (3) demonstrate an example of angular deviations in the knee-ankle coupling in the sagittal plane. In the beginning, both groups seem to use the same strategy, but the skilled group present an early angular displacement increase (around 40% to 50% of the cycle) compared to unskilled. Also, there is a difference in the last 10% of the cycle, where the skilled show a greater variation in their performance.

Although, the present results corroborates previous studies, where skilled football players demonstrated a coordination mode involving less joint involvement at the proximal joints and greater joint involvement at distal joints, when compared to unskilled practitioners [2].

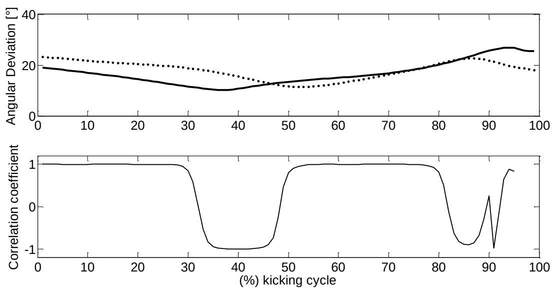

Figure 3. Angular deviations vs. kicking cycle (0% = touch of the support foot on the ground, 100% = touch of the kicking foot on the ball) for the knee-ankle couplings for skilled kicking leg (solid line) and unskilled kicking leg (dotted line) movement in the sagittal plane. The second row presents moving correlation coefficients (each 10% of the cycle) of the angular deviations of both groups.

CONCLUSIONS

We can conclude that skilled and unskilled practitioners present different coordinative strategies in kicking a football mainly in the more distal couplings. The major difference between skilled and unskilled practitioners was found in the transverse movement of the knee-ankle joint coupling. Kicking is also a task that can provide useful information to a better understanding of other skill movements.

ACKNOWLEDGEMENTS

Authors would like to thank the support of Fapesp (2012/03097-2), CNPq (304989/2009-6) and Capes (9823-12-3).

REFERENCES

1. Chow, J. Y., et al. Coordination changes in a discrete multi-articular action as a function of practice. *Acta Psychologica*, **v.127**, n.1, p.163-176. 2008.
2. Chow, J. Y., et al. Variation in coordination of a discrete multiarticular action as a function of skill level. *Journal of Motor Behavior*, **v.39**, n.6, p.463–479. 2007.
3. Hamill, J., et al. Using coordination measures for movement analysis. *In: XXIII International Symposium on Biomechanics in Sports*. Beijing, 2005. 33-38.
4. Miller, R. H., et al. Variability in Variability in kinematic coupling assessed by vector coding and continuous relative phase kinematic coupling assessed by vector coding and continuous relative phase. *Journal of Biomechanics*, **v.43**, n.13, p.2554-2560. 2010.