INTERMUSCULAR COORDINATION ANALYSIS OF SKILLED DOUBLE-HANDED BACKHAND AND SINGLE-FOREHAND PLAYERS

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INTRODUCTION

Experienced coaches and players may easily identify performance by visual observation, whereas testing tools have been used to evaluate players' motor performance to understand coordination mechanisms [1]. Electromyography (EMG) has been widely applied in studies of intermuscular coordination, and is helpful to categorize and understand the agonist and antagonist muscular activity at different skill levels in many sports, including tennis. In tennis, each player usually has a better skill level for one single stroke (e.g., forehand or backhand), and also has his or her own advantage in side movements. Although this phenomenon can be easily judged by professional coaches, the underlying EMG patterns are unknown. Agonist-antagonist co-contraction patterns for stability and the strong agonist pattern for acceleration has been studied in simple fast goal-directed movement [2,3], but not for tennis. Therefore, agonist-antagonist pattern in terms of onset-offset and normalized amplitude with MVC (Maximum Voluntary Contraction), and their ratio were analyzed to understand EMG patterns and to examine whether the agonist-antagonist ratio can be an effective parameter to assess intermuscular coordination in single- forehand and double-handed backhand strokes.

METHODS

Female tennis players participating in this study were characterized into two groups: skilled single-forehand and double-backhand. Subjects were typically right-handed players. A reliability assessment for identifying skilled single-forehand or double-backhand abilities was obtained from three expert tennis coaches prior to the study, and was highly consistent. Surface EMG data at a sampling rate of 1200 Hz, were collected with a Biovision EMG System synchronized with a JVC digital camera at sampling rate 120 Hz by a simple circuit with LED. Muscles measured were the biceps brachii, triceps brachii, flexor carpi and extensor carpi muscles on both right and left arms. The backhand and forehand stroke was divided into three phases: Phase I, the preparation, began with the backswing and ended with the first forward motion of the racket; Phase II, acceleration, ended at impact; Phase III, the follow-through, ended with completion of the swing (Figure 1).

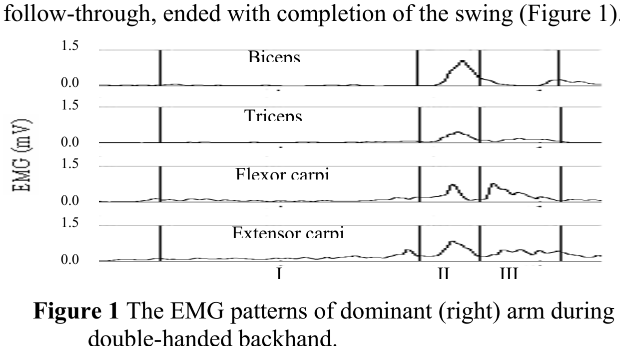

Figure 1 The EMG patterns of dominant (right) arm during double-handed backhand.

We analyzed individually the four best strokes (as evaluated by both subject and experts' observation) from a total of 15 backhand and 15 forehand strokes after a proper warm-up. Maximum voluntary isometric contraction (MVC) for each muscle was used to normalize values. The EMG signal was band-pass filtered at 10 to 500 Hz, full-wave rectified, and the integrated.

RESULTS AND DISCUSSION

Elbow flexor/extensor EMG ratio in the acceleration phase differed significantly between the two groups, as demonstrated for both forehand and backhand strokes with the example data (Table 1). A higher elbow flexor/extensor EMG ratio characterized the left arm of skilled double-handed backhand players and the right arm of skilled single-handed forehand players, although both groups are right-arm dominant. For skilled left double-handed backhand players, a stronger agonist activation pattern was evident in double-handed movements but also demonstrated was stronger co-contraction pattern for forehand movements. However, the opposite trend was seen for skilled right forehand players, who demonstrated stronger agonist activation in forehand movements, but also stronger co-contraction patterns for double backhand movements. The characteristics of elbow acceleration were clear in terms of a stronger agonist in the preferred skilled movement (either double back hand or forehand), and showed a stabilization function in terms of higher co-contraction for the less skilled movement. The elbow uncocking movement skill was different from the traditional method in that only shoulder joint was unlocked. However, the wrist flexor/extensor normalized EMG ratio demonstrated a stabilization function even for the skill movement, which differed from what was seen in the elbow. This may derive from the necessity of stabilization in the distal segment for withstanding impact.

Table 1: Ratio of elbow flexor/extensor normalized EMG for skilled double- backhand and single- forehand players

Elbow(n=4)	**Group I** Skilled double-backhand		**Group II** Skilled single-forehand	
Movement Arm	forehand right hand	backhand lefthand	Forehand right hand	Backhand left hand
Phase I	1.55±0.30	3.26±0.81	3.76±0.59	0.78±0.17
Phase II	1.84±0.28	8.71±1.61	6.87±0.49	1.38±0.22
Phase III	0.99±0.17	1.60±0.30	1.80±0.60	0.69±0.10

CONCLUSIONS

Tennis players showed a higher elbow flexor/extensor ratio for their preference arm during the acceleration phase of their stroke when performing their skilled movement. This may increase the elbow joint acceleration more efficiently. In addition, the parameter of the ratio of agonist to antagonist EMG can usefully assess coordination performance in skilled tennis strokes.

REFERENCES

1. Wang ST et al, *Physical Edu J*, **36**, 85-94,2004
2. Milner TE, , *Exp Brain Res*,**143**, 406-416,2002
3. Jaric S et al., *Eur J Appl Physiol Occup Physiol*, **71**, 464-468,1995.