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Differences between EMGs of Forearm Skeletal Muscles for Flick Strokes against Backspin and No-spin Services in Table Tennis

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Abstract: We have conducted an experimental study to clarify the differences between the EMGs for the forearm skeletal muscles when receiving backspin and no-spin services with a forehand flick stroke. An elite Japanese table tennis player participated as a subject in this study. A Chinese coach, acting as a server, sent a service ball and the subject returned it with a forehand flick stroke. The service ball speed was approximately 4 m/s. The receiver was informed whether the service ball had spin or not. A significant difference ($p<0.05$) between the two kinds of services was shown for the electrical discharge amount of M. extensor carpi ulnarise (Backspin: 122.06±42.10 and No-spin: 87.12±36.39microV). There were no significant differences for other muscles. It is assumed that the electrical discharge of M. extensor carpi ulnarise of the subject for 15ms just before the impact is concerned with controlling the racket surface.

Keywords: table tennis, forehand flick stroke, EMG, forearm skeletal muscle, racket control

1.Purpose

There are several techniques in table tennis for returning balls that land near the net. These techniques are considered extremely important, and closely related to competition results.

The flick stroke is an aggressive topspin return of a ball that lands near the net. The ball is flicked lightly using the wrist and a little elbow action immediately after it bounces on the receiver's court (Figure 1).

In spite of the flick stroke's importance, there have been few studies on it (Yoshida et al., 1997, 1999; Kasai et al., 1999). Therefore, the mechanism of the stroke is not well understood.

The purpose of this study was to clarify the EMGs for the forearm skeletal muscles when receiving backspin and no-spin services with a forehand flick stroke. The present report is the sequel to our previous report (Yoshida et al., 2004).

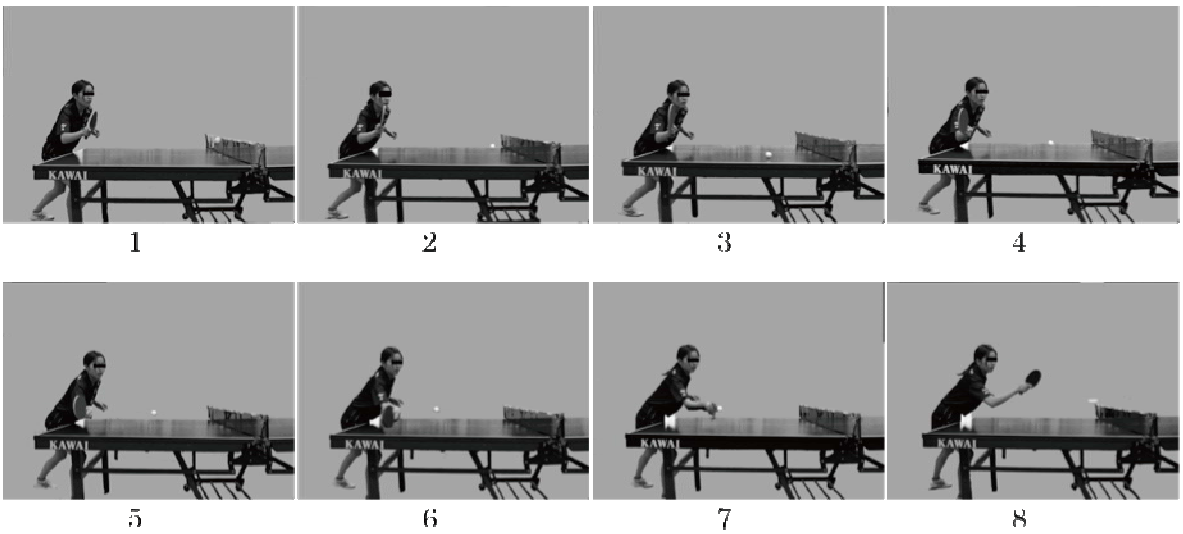

Figure 1. An example of a forehand flick stroke

These pictures show the forehand flick stroke every 0.05 s. The instant of ball contact was around 7.

2.Methods

2.1 Subject

An elite table tennis player participated as a subject in the present study. He was a finalist in the All American Open U-22 (1999) and a member of the Japanese national team of the 2001 Universiade. Table 1 shows the characteristics of the subject. We obtained his agreement to attend the experiment after explaining its purpose and safety aspects.

2.2 Experimental Procedure

A Chinese coach acting as a server sent a service ball and the subject returned it with a forehand flick stroke. The service balls were controlled to land in a circle of 20cm radius on the right half court of the receiver. The center of this circle was 50cm from the end line and 40cm from the sideline. The service ball speed was approximately 4m/s. The receiver was required to return the ball into a 25cm radius circle on the right half court of the server. The center of this circle was 95 cm from the net and 30 cm from the sideline. Two cases, backspin (B) and no-spin (N), were examined. There was little variability in service ball speed and spin. The receiver was informed whether or not the service ball would have spin before the server served. The tests were repeated for each case until the receiver succeeded in returning the ball precisely more than 5 times as required. In practice, about 10 trials were necessary for each case.

2.3 Measurement Items

Measurements of muscular activities were made for the following muscles: extensor carpi ulnaris, extensor digitorum communis, extensor carpi radialis lognus and brevis, flexor carpi radialis, and pronator teres. Muscular electrical discharge was measured by a surface dipole dielectric method. After treatment to reduce skin resistance, miniature bio-electrodes 12mm in diameter (NT-611U: Nihonkoden, Tokyo, Japan) were set at 20mm centers along the line of muscles following the Zipp method (1982). The angles of the elbow joint and wrist joint were measured by goniometers (M110, M180: Penny and Giles, Gwent, UK). The angle of the elbow joint showed flexion and extension, and the angles of the wrist joint showed flexion and extension, abduction and adduction. Acceleration sensors (AS-100HA: Kyowa Electronic Instruments, Tokyo, Japan) were installed on the table and racket to record the moment of bouncing. Using a data analyzing system (MP100WS: Biopac Systems, California, USA) and PC (iMac: Apple Computer, California, USA), all the analog signals were sampled at a sampling frequency of 1kHz and converted to digital data for further processing. Furthermore, the motion of the subject in the test was recorded by a digital video camera (DCR-TRV10: Sony, Tokyo, Japan). EMG electrodes and the goniometers set on the racket arm are shown in Figure 2.

2.4 Data Analysis and Statistical Work

The integration value was derived from the electrical discharge at each of the subject's muscles by a waveform recorded 30ms and 15ms before ball impact. The derived value was conducted (t test of Student) for the difference of the corresponding average. The

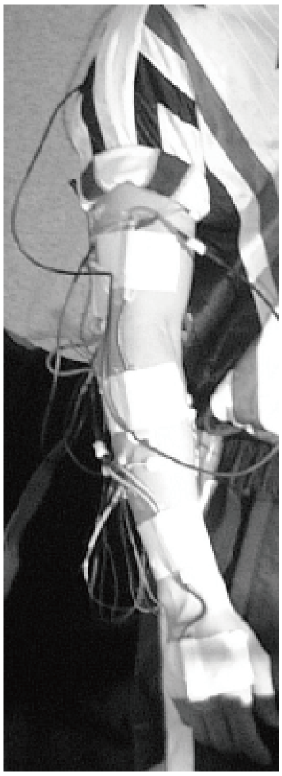

Figure 2. Setting EMG and goniometers

Table 1. Characteristics of the subject

Age	Racket Arm	Grip	Rubber	Number of competitive years
22	right	shakehand	reversed pimpled	14

significant level was $p<0.05$.

3. Results

Figure 3 shows the electrical discharge amount for each muscle for 30ms just before impact. The electrical discharge amounts for B and N were B: 254.88±62.71 and N: 226.60±76.95microV (M. extensor carpi ulnarise), 75.88±16.65 and 62.40±21.65microV (M. extensor digitorum communis), 88.46±17.23 and 76.13±19.80microV (M.extensor carpi radialis lognus and brevis), 111.99±49.15 and 74.06±42.19microV (M. flexor carpi radialis), 130.89±19.34 and 106.10±41.18microV (M.pronator teres), respectively. It was observed that the electrical discharge amounts for B for M. flexor carpi radialis was greater ($p=0.053$). However, there was no significant difference for any of the muscles.

Figure 4 shows the electrical discharge amount for each muscle for 15ms just before impact for both services. A significant difference ($p<0.05$) was shown

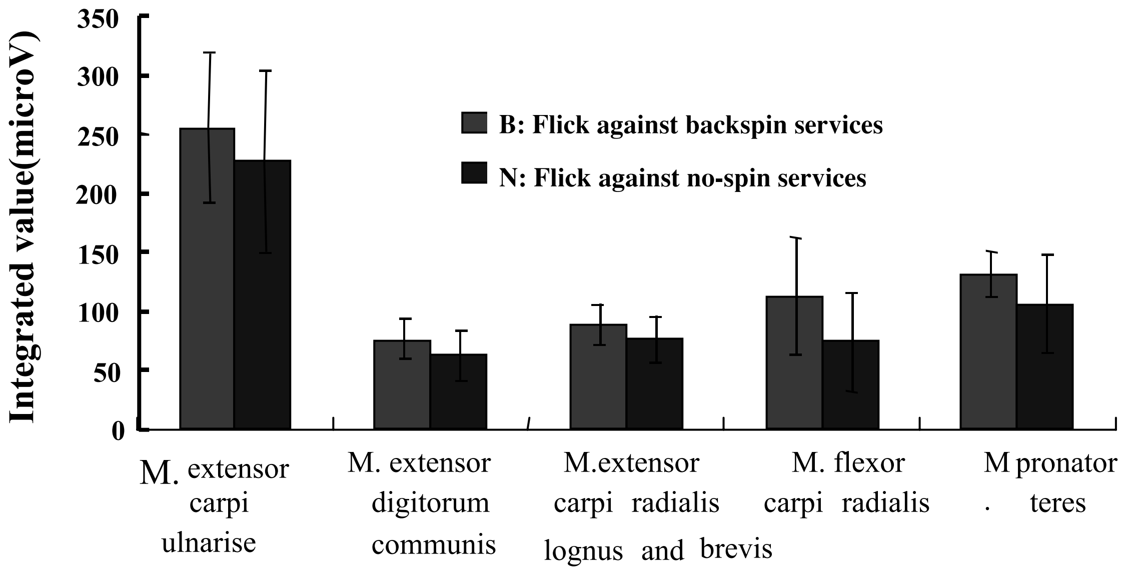

Figure 3. Integrated values for 30ms just before impact during forehand flick strokes

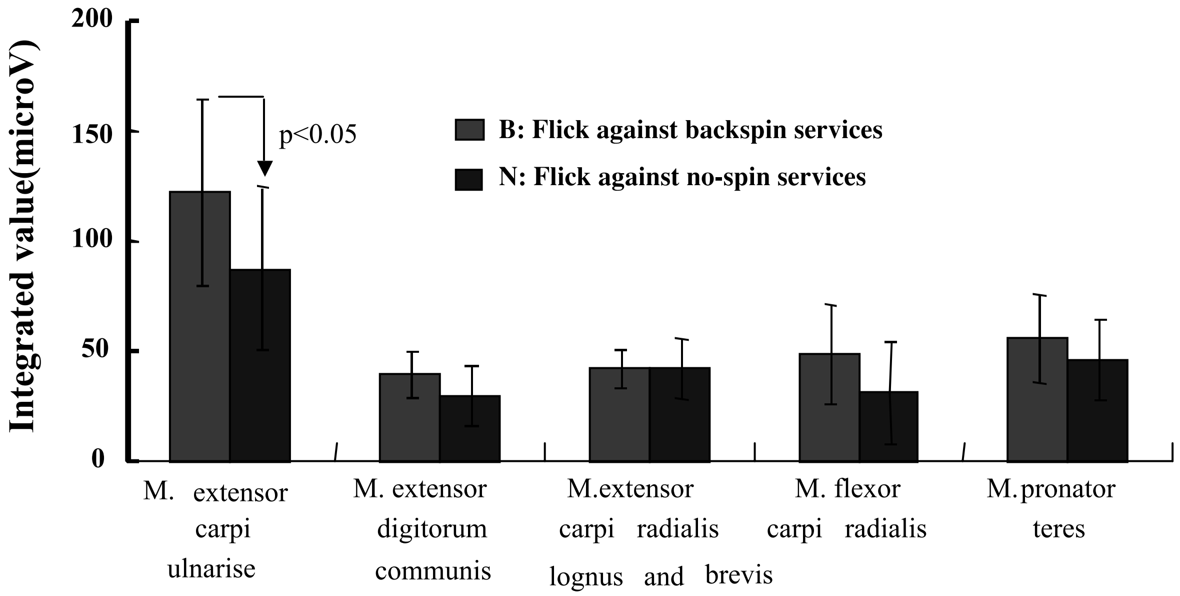

Figure 4. Integrated values for 15ms just before impact during forehand flick strokes

for the electrical discharge amount of M. extensor carpi ulnarise (B: 122.06±42.10 and N: 87.12±36.39microV). There were no significant differences for other muscles (M. extensor digitorum communis : 39.20±10.35 and 29.88±13.28microV, M.extensor carpi radialis lognus and brevis : 41.85±8.57 and 41.96±13.52microV, M. flexor carpi radialis : 48.79±22.55 and 30.98±23.37microV, M. pronator teres : 55.55±19.82 and 46.17±18.32microV).

4. Discussion and conclusion

Until now, there has been no knowledge about the relationships between EMGs for the skeletal muscles of the forearm and racket control coping with service balls with different rotations.

From the results described above, there were substantial differences in the electrical discharge amount of M. extensor carpi ulnarise for 15ms just before impact during the forehand flick stroke for the elite player for service balls with and without backspin. It was suggested that the elite player properly used the M. extensor carpi ulnarise to receive backspin and no-spin services with a forehand flick stroke.

It is said that elite table tennis players move their racket fast while controlling the racket surface just before impact to return with a forehand flick stroke. It is assumed that the electrical discharge of M. extensor carpi ulnarise of the subject for 15ms just before the impact is concerned with controlling the racket surface.

Future studies are needed to examine the characteristics of racket control when receiving against the two kinds of service spin for other elite table tennis players, classified with respect to the type of technical individual difference by movement analysis.

5. Acknowledgement

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