Distribution of contact points on the racket when hitting 40mm balls

Hisao ISHIGAKI
Aichi Institute of Technology, Japan

Abstract Two experiments on 40mm balls were performed.
1. The velocities of 40mm balls (2.7g) and 38mm balls (2.5g) were measured by propelling the balls from a table tennis machine at three speeds; high, middle and low. Then the velocity was compared for each machine speed. Hardly any difference was shown in ball velocity between the 40mm ball and the 38mm ball at any of the machine speeds. This result agreed with that of the velocity simulation by Tsuji et al (1999) and Tsuji (2000) using a personal computer.
2. Using 14 college table tennis players, the contact point on the racket was investigated for the 40mm ball. Each player hit a 40mm ball and a 38mm ball 40 times respectively, and the center of distribution for the 40 contact points was calculated. The result showed that the center of contact points moved closer to the racket center (away from the top edge) when hitting the 40mm ball than when hitting the 38mm ball. The mean distance of movement was about 6mm among the 14 players. This phenomenon was observed in almost all the players and was also seen with both the penholder racket and the shakehande racket.
It is surmised that the increased ball weight requires the players to hit the 40mm ball at a point closer to the racket center to overcome the increased ball pressure.
(*Key words: 40mm ball, ball velocity, contact point, spontaneous adjustment*)

1 Introduction

The official use of the 40mm table tennis ball commenced in 2000. Prior to that, I carried out a questionnaire survey on the 40mm ball with college table tennis players in March 2000. The results showed that the players noted two sensations:

1. The 40mm ball was felt to be slower than the 38mm ball.
2. The 40mm ball was felt to be heavier than the 38mm ball when striking it with a racket.

These two sensations seem to be interrelated. It is not known whether the 40mm ball is actually slower than the 38mm ball but, if the player feels the 40mm ball heavier when striking it, such a sensation may lead him/her to feel that the ball is slower.

Concerning 1, Prof. Tsuji and his associates (Tsuji and Muguruma, 1999;

Tsuji, 2000) have performed the calculation of the ball speed on a personal computer, varying the size and weight of the ball, atmospheric pressure, and so on. They concluded that there was almost no difference in the velocity between the 40mm balls with 2.7g weight and the 38mm balls with 2.5g weight. Their conclusion is, however, based on the results gained from a computer simulation. Because of this, it was not clear whether the real velocity differs between the 40mm balls and the 38mm balls. Therefore, I measured the actual velocity of the 40mm balls and the 38mm balls in the first experiment.

Concerning 2, no experiments had been conducted previously. If a ball is felt to be heavier, any player will try to make the proper adjustments. In my opinion it was expected that the adjustments will be achieved by changing the contact point on a racket.

Then, in 2nd experiment, I measured the contact point of 40mm balls and 38mm balls, and investigated whether the distribution of contact points would differ depending on the type of balls used.

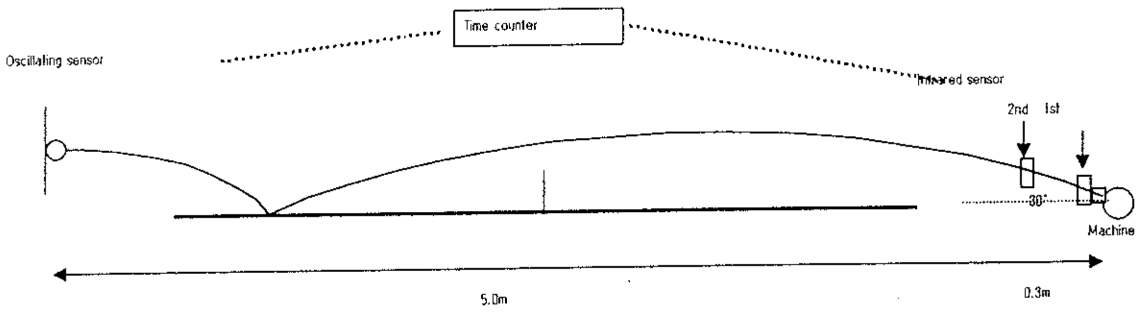

Figure 1. Experimental method (1st experiment)

2 1st experiment: Comparison of velocities of 40mm and 38mm balls

2.1 Methods

The ball was discharged using the table-tennis machine. The angle of launch was set at 30 degrees. The infrared sensor and oscillating sensor were set. The 1st infrared sensor was set to the exit position of a machine. 2nd sensor was set to 30cm from the exit of machine (Figure 1).

The ball bounces once on the table and it hits a board attached to the oscillating sensor. The distance from the machine to the board is 5m. Using a time counter, the times of flight between the 1st sensor and the 2nd sensor and between the 1st sensor and the oscillating sensor were measured. The initial velocity of a ball was determined by measuring its velocity between the 1st and 2nd sensor.

Ten 40mm balls and ten 38mm balls were used. The average and the standard deviation of diameter were 39.995mm ± 0.038 and 37.68mm ± 0.054, and average and the standard deviation of weight were 2.718g ± 0.016 and 2.495g ± 0.015 respectively.

2.2 The ball speed settings

The ball discharging speeds were set by the speed (revolution) control dial on the ball machine; the middle speed was set at 50 revolutions, the high speed at 85 revolutions and the low speed at 30 revolutions per second.

2.3 Number of measurements

The ball velocity was measured 30 times at each speed.

Table 1. Average velocity for 38mm and 40mm balls as a function of projection speed.

km/h

	40mm	38mm	Difference	
High	40.496	39.661	0.834	**
Middle	33.483	33.065	0.418	**
Low	23.174	22.287	0.887	**

T-test ** p<.01

2.4 Results

Identical initial velocities between the 1st and 2nd sensors was maintained for both 40mm balls and 38mm balls among three speed conditions. No significant difference was observed in the initial velocities between the 40mm and the 38mm balls at any of the 3 machine speeds.

Then, the time required for the ball to travel the 5m distance between the 1st sensor and the oscillating sensor was determined. The value gained was then converted into the velocity per hour as shown on Table 1.

The velocity of the 40mm balls was significantly higher than that of the 38mm balls at all of the 3 machine speeds. However, the difference in the average velocity was very small, being 0.834km/hour at the high machine speed, 0.418km/hour at the middle speed and 0.887km/hour at the low speed.

2.5 Conclusions

The difference of speed between 40mm balls (2.7g) and 38mm balls (2.5g) is very small. This experimental result supports the computer result of Professor Tsuji and his associates (Tsuji and Muguruma, 1999; Tsuji, 2000).

3 2nd experiment: Comparison of distribution of the contact points on a racket with 40mm and 38mm balls

3.1 Methods

Fuji photo film PRESCALE was used in order to record the contact point in the 2nd experiment. PRESCALE is a pressure sensitive record sheet. It is a duplex type, and contact points can be marked on a lower sheet in red color. The ball is struck with a racket on which this type of sheet is pasted. This sheet was set on the surface of each subject's racket and trimmed to its exact form. The two dimensional coordinate axes are drawn on the sheet, with the X axis along the handle and the Y axis normal to it, and with the origin set at the geometric center of the racket.

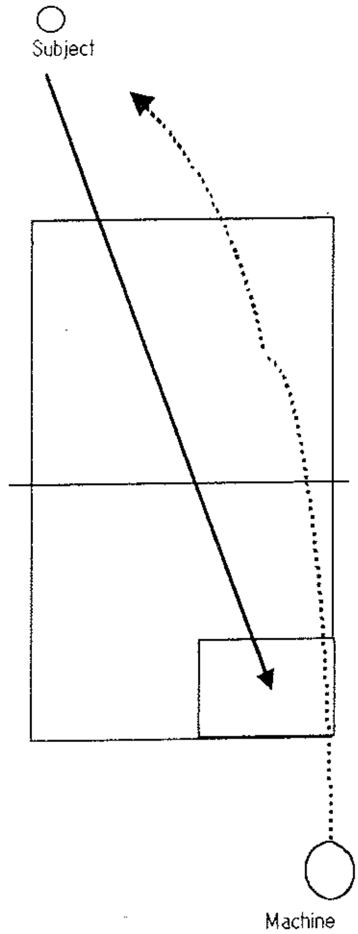

Figure 2. Experimental method (2nd experiment). Each subject was requested to strike a ball back to the rectangular area in the lower right corner in the diagram.

3.2 Subjects

14 college table tennis players were used (8 males and 6 females), 8 pen holder racket users, and 6 shake hand racket users. Each subject was requested to strike the ball back to the rectangular area in the lower right corner in the diagram (Figure 2). The distance between the ball machine and the subject was set to 5 meters. The ball speed was set to "middle" as described in the first experiment. Using a forehand stroke, the subject hit a 40mm ball and a 38mm ball 40 timeseach. Sheets were changed every 10 times

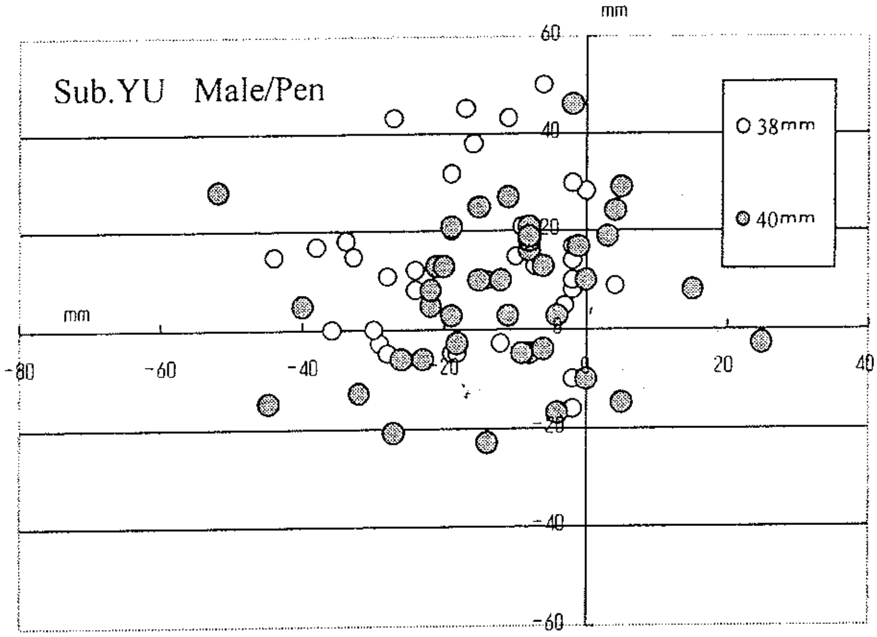

Figure 3. Distribution of the contact points (Subject YU).

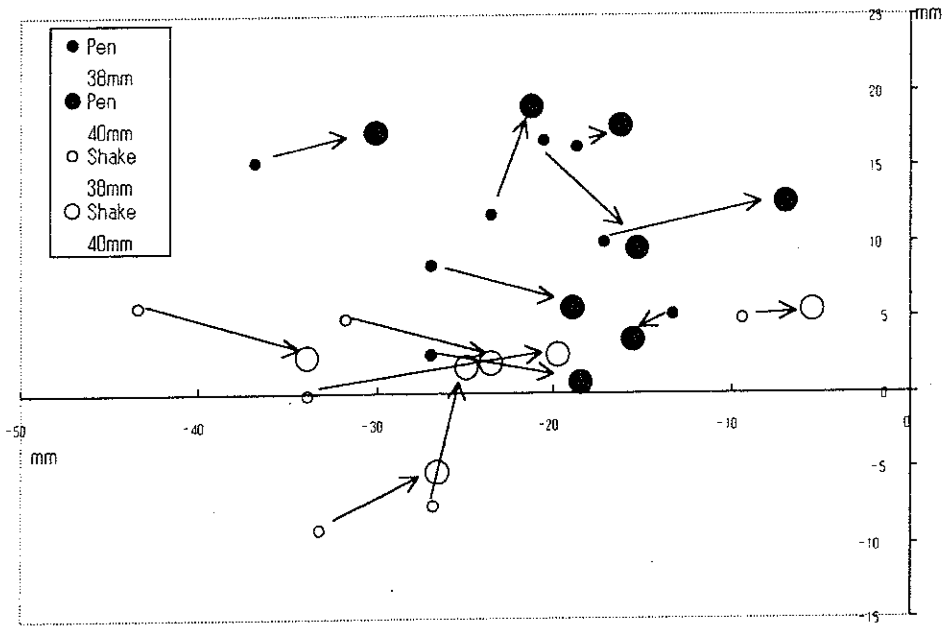

Figure 4. Shift of the center of contact point distribution for each player.

3.3 Results

Figure 3 is the distribution of the contact points generated by one of subjects. Small and large points correspond to the 38 and 40mm balls, respectively. The center of each distribution was calculated from the corresponding contact points. Figure 4 shows the shift of the center of point distribution between the 38mm and the 40mm balls.

Black points indicate a penholder racket while white points indicate a shakehand racket. And smaller points correspond to 38mm balls while larger points to 40mm balls. It is found from the figure that the penholder rackets have contact points above the X axis and that the shakehand rackets are struck near the X axis. Another important trend is that the shift in the contact points occurs toward the geometric center of the racket away from the tip. This result seems to be common to all the subjects, regardless of the racket type (Figure 4).

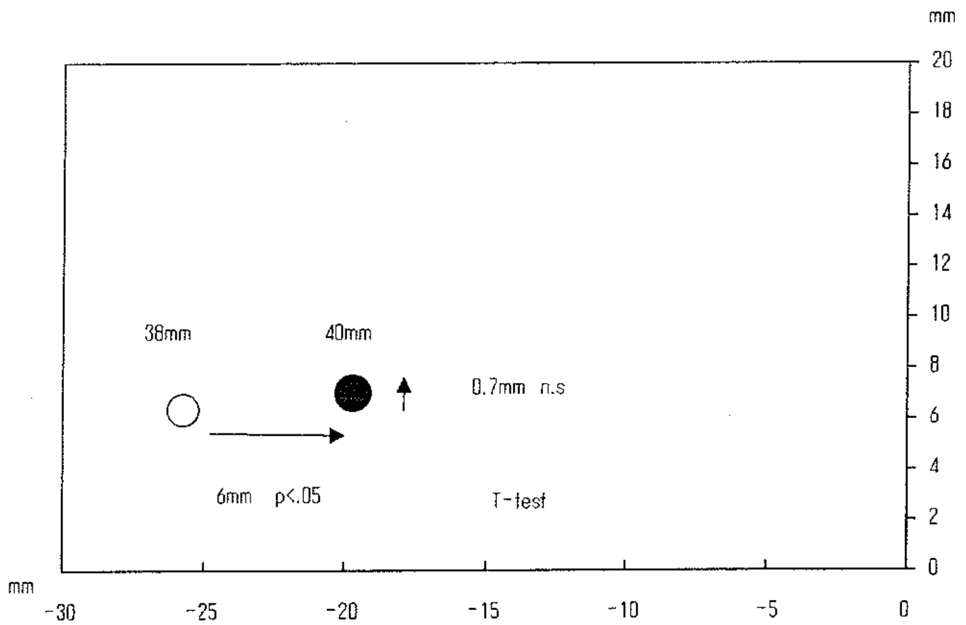

Figure 5. Average contact point of 14 players. The center of contact points was shifted toward the geometric center of the racket when the 40mm balls were used.

Figure 5 is the average position of 14 subjects. The shift occurs in the positive direction along the X axis by 6mm (p<. 05), and also in the positive direction along the Y axis by 0.7mm (ns). These results show that the center of contact points is shifted toward the geometric center of the racket (away from the tip) when the 40mm balls are used. This shift is probably explained as a spontaneous adjustment of the players to compensate for the increased torque in striking the heavier 40mm balls.

4 Conclusions

The two experiments revealed the following:

1. There is no difference in the average velocity between the 40mm balls and the 38mm balls.

2. Contact points on the racket shift toward the geometric center of the racket when striking the 40mm balls. This shift may be explained as spontaneous adjustments by the player to compensate for the increased torque in striking the 40mm balls.

5 References

Tsuji Y and Muguruma Y (1999) Numerical simulation of motion of table tennis ball (effect of ball diameter). Personal communication.

Tsuji Y (2000) Consideration of 40mm ball based on aerodynamics. The 6th International Table Tennis Federation Sports Science Congress.