

7 Technical contrastive analysis after ping-pong diameter altering

K. X. Bai, X. Hong, P. Hu and H. Yin

*Wuhan Institute of Physical Education, Wuhan, China, 430079.
bkx918@263.net.*

1 Introduction

When the diameter of table tennis ball officially changed from 38 mm to 40 mm in 2000, someone believed that the changes would have negative effects on Asian players including Chinese athletes while benefiting European players. But in fact, we will find that the results of Asian players have been greatly improved comparing the match results now with the results of the match in which smaller balls were used. It can be concluded that this change may be more suitable to the skill execution of Asian players. So what is the reason? In this paper, we will discuss the problem in two aspects: (1) basic biomechanical knowledge will be used to analyze the principles and the features of force, revolving, flight path of table tennis ball, which will help the athletes to realize the table tennis perceptually and rationally better, and enhance their ability of judgment to nature of ball, and also perfect the skill; (2) by studying the alternation of table tennis angular velocity, flight path, and discussing this kind of alteration would bring the effect of Chinese athlete further, and it is able to supply the service better for the athletes executing the movement technique level, producing a better movement effect and improving scientific degree of movement training.

2 Methods

Measuring method of spin speed of table tennis: The way of testing the table tennis ball spin speed and spin angle by means of a US Ariel three - dimensional resolution system is explained as followings: Design of color ball: the table tennis ball was coated with three pigments of red, yellow and white colors. Design of lights: In order to identify three colors on the table tennis ball more clearly and exactly through images, the lights in the table tennis hall (experiment place) must be very bright. Therefore, all the lights in the hall were turned on and also additionally mount 4 iodine - tungsten lamps at four corners.

Videotaping: We extend at the side of the ball table a high - speed digital camera with a sampling frequency of 300 frames per second to record the

movement situation of topspin ball and under – spin ball respectively.

3 Results and Discussion

The movement of a table tennis ball is determined by the external forces acting on it, which mainly includes the normal force and frictional force from the paddle, gravity, and the air resistance (fluid force). Influence of gravity can be neglected since a table tennis ball is very light. In the course of table tennis moving, table tennis revolving will lead to air revolving around the surface and cause the difference of air velocity, and thereby the ball will suffer an air – press and flight along a curved path. As for the reasons, which lead to the complication of the movement of table tennis ball in the air, especially, after increasing the diameter of table tennis ball. We will make mechanical analysis on it at the following points.

3.1 Change of forward striking velocity after increasing diameter of table tennis

After increasing the diameter of a table tennis ball, an increase in weight is not obviously. If the impulse imposed on a ball is fixed, we can conclude from the impulse – momentum relationship ($F \cdot t = mv_2 - mv_1$), that the off – paddle speed of table tennis ball will not decrease drastically. In the course of flight, owing to the influence of air resistance, table tennis forward velocity will decrease appreciably. Diameter increasing will bring an increase in head – on area, according the formula $s = \pi r^2$, and thus lead to an increase in air resistance, according $f = cv^2s$. Owing to the small increase in air resistance, the influence on flight velocity can be neglected. As a result, for athletes of fast – attack style of play, increasing diameter of table tennis will not have much influence on them. As the skill feature of Chinese athletes is combining fast attack with loop attack, especially the former, an emphasis in speed is the key reason why Chinese athletes can still win matches. So it is proved that the advantage of fast attack still exists. Comparing the result in major competitions, it is demonstrated that Chinese athletes have not been affected by the change in ball size. In other words, the fast attack style is as effective as before.

3.2 Change of spin speed after increasing diameter of table tennis

Spin of table tennis ball can be classified as topspin, under spin, sidespin and composite spin. Table tennis ball rotates in the air around its own center. This will cause changes of its flight path and therefore changes the speed and angle of the ball when it rebounds off the opposite table. Therefore, one should understand and grasp the underlying principles of table tennis ball movement by starting from understanding the spin of table tennis ball first. The table tennis

ball spin speed and spin direction are normally analyzed from two aspects: A. Analyzing the table tennis ball's spin speed and spin angle through analyzing the forces acting on table tennis ball; B. Measuring the table tennis ball's spin speed and direction through tracing special marks of color ball by means of high-speed photography or high-speed videotaping-image resolution method.

3.2.1 Analysis on the forces on the ball and spin

The forces imposed on the ball by a paddle can be resolved into two components: one is the normal thrust (F), and it acts through the cg of the ball and translate the ball forward; the other one is imposed frictions on the surface of the ball owing to the viscosity of the paddle gooey, and it can "sticking to the ball" and thereby the ball can be "brought" upward or downward or left or right from its backside. In this way, the ball will be subjected to an additive upward or downward or left or right torque (T) and causes the ball to rotate. From the formula $T \cdot t = mr\omega_2 - mr\omega_1$ we know that: The larger the T , the greater the angular velocity (ω).

Composite spin is a kind of spin that combines topspin or under-spin with sidespin. Taking a panoramic view of important matches in local and international competitions, it will not be difficult to find that the composite spin is commonly used by the player, because it is not easy for an opponent to predict and judge the ball speed, spin and rebound angle.

3.2.2 The change of revolving speed after increasing diameter of table tennis

As the size of a table tennis ball becomes larger, its radius increases accordingly. According to the definition of moment of inertia ($I = m \cdot R^2$), we can conclude that the increase in the radius will increase the moment of inertia greatly. If the impulse the paddle imparts on the ball (C) is fixed, it can be inferred from the equation $I \cdot \omega = C$ that the angular speed of the ball will decrease. As European athletes rely heavily on looped flight path, for his threat towards his opponent roots from the angular speed of the ball, the effectiveness of this style of play will certainly decrease greatly. In other words, the change from small ball into big ball will have more negative effects on the loop style. However, some coaches don't agree with my viewpoints, they argue that spin speed of the larger ball will not reduce in practice, so the next thing to do is to measure the spin speed of table tennis.

3.3 Analysis on flight path of table tennis ball

When analyzing flight path of table tennis ball, we need to take into account the degree, angle and direction of the acting force imposed by the paddle on the ball and the way it is imposed firstly. However, the acting force imposed by the

air also affects the flight line of the ball because it is light and small.

3.3.1 Influences on the flight path of table tennis ball from air resistance

In this sect, we'll mainly discuss how to bring air - press acting on the ball by using some fluid theories. In the course of table tennis ball's flight, two velocities exist usually (one is normal speed, and the other is spin speed), correspond to its suffered force (Figure 1).

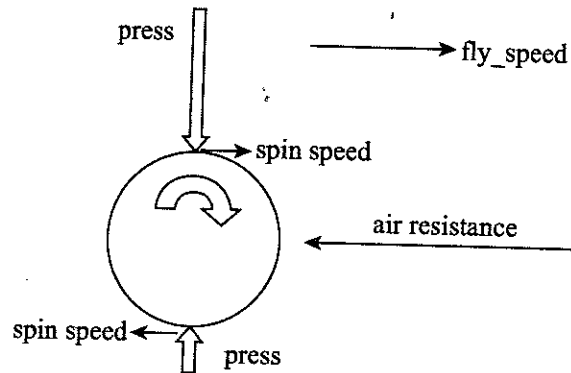


Figure 1. Influences on the flight path of table tennis ball from air resistance

For a topspin ball, owing to viscosity of the ball's surface, the air around the ball will spin with it in the same direction. In addition, when a ball flies forwards, the air's head - on resistance is backward, the direction of the air immediately above the ball is opposite to one of the air's resistance, and the air's flowing speed decelerates; while the direction of the air revolving speed below the ball is the same as one of the air's resistance, and the speed accelerates, which leads to the speed difference between the air above - below surface of the ball, the flowing speed of the air above the ball is slower than that below. According to the principle of hydromechanics, the faster the speed of air current is, the less the pressure intensity is. So when the ball flies forward, the pressure intensity on the lower part of the ball - P' is less than that on the upper part of the ball. And there is a difference - P between above - below surface of the ball and the direction of P is downwards. Therefore, the ball falls down under the action of P. However, under spin is the opposite way. The pressure intensity on the lower part of the ball - P' is larger than that on the upper part of the ball and the difference between above - below surface of the ball causes the ball to floats upwards.

3.3.2 Variety of flight path owing to the small ball being replaced by the big ball

What discussed below is a change of pressure difference with a ball's size changing, by formula $i \cdot \varpi = C$ and $I = m \cdot R^2$ and $V = R \cdot \omega$,

We can obtain $V = C/mR$, assuming: ΔV is a variety of the air flying speed of the above - below surface of the ball owing to acting of the air resistance.

So for a topspin ball, $V_{UPPER} = V - \Delta V$ and $V_{UNDER} = V + \Delta V$,

$$\text{And therefore } \Delta P = \frac{1}{2} \rho [(V + \Delta V)^2 - (V - \Delta V)^2], \Delta P = 2\rho V \cdot \Delta V \\ = \frac{2\rho \cdot C \cdot \Delta V}{mR},$$

The bigger the R is, the less the ΔP is. While the small ball changed into big ball, its revolving speed slowed down apparently. This resulted in the decrease in pressure difference, and then brought a less affect of flight path.

4 Conclusions

(1) Increasing of diameter of table tennis, forward striking velocity will not reduce.

(2) The spin of table tennis ball includes topspin, under spin, sidespin and composite spin. Each kind of spin suffers from a kind of the frictional force of the different direction.

(3) Revolving speed after increasing diameter of table tennis will reduce greatly.

(4) Increasing of diameter of table tennis brings a less affect of flight path.