The Biomechanical principles of the Looping Technique

I-The mechanics of Loops

Loops are produced by forcefully “**brushing**” the middle or upper part of the ball with the bat so that it moves in a looping curve. The quality of a loop depends on the magnitude and the direction of the force applied to it, the duration of the impact between the bat and ball, the point of impact on the ball, and the resistance of air met by ball during its flight.

1: magnitude and direction of force

Travelling in a curve, the looping ball revolves at an even speed while being “**Brushed**” by the bat but at a changing speed when resisted by the air after leaving the bat, The degree of the spin of the ball may be measured by its angular acceleration.

The magnitude and direction of the force applied to the ball have an important bearing on its spin. As illustrated in Diagram 1, the force F may be broken into two components, $F_1 (= F\cos\propto)$ and $F_2 (= F\sin\propto)$.

Here F_1 stands for friction and F_2 the force of impact directed at the centre of the ball.

Diagram 2 shows F', the force directed at the centre of the ball O to drive it forward, and M, the momentum which effects the spin of the ball. Here $F' = F$ and $M = FL = FR\cos\propto$, R being the radius of the ball.

M is also related to β, the angular acceleration, and I, the moment of inertia.

Thus $\beta = \frac{M}{I}$

In other words, the greater the value of M, the greater the angular acceleration and the greater will be the spin of the ball.

As may be seen from Diagram 3, the direction of F is related to the angle $\propto$.

The smaller the value of $\propto$, i.e., the “thinner” you cut the ball with your bat, the greater will be the momentum since $M = FR\cos\propto$. Conversely, the greater the value of $\propto$ (within a certain limit, of course), the smaller will be the momentum.

To sum up, the spin of a ball is related to M, or to the magnitude of F and the direction of its application.

To put it more precisely, it is related to the amount of friction ($= F\cos\propto$) given to the ball and the direction to which the friction is applied, while the angular $\propto$ depends on how thin you cut the ball with the bat.

2: Duration of impact with the ball

From $M = \beta I$ we can drive the equation $Mt = \omega I$, “t” being the duration of impact and “ω"

the angular velocity of the spinning ball. In other words, $\omega = \frac{FRt}{I}\cos\propto$.

From this we can see that “ω" , the angular velocity of the ball at the moment it leaves the bat, is related not only to “F” and “$\propto$” but also to “t”. A longer duration of impact with the ball, therefore, will increase the spin of the ball.

3: Point of impact on the ball

As shown in Diagram 4, the angular **α** remains unchanged so long as the ball is cut at the same “depth” all the time. However, the direction of F varies with different points of impact on the ball. A downward direction of F causes the ball to travel in a low trajectory and at a high speed (Diagram 5a).

Since a faster shot is more difficult to return, it is advisable to hit the ball at a higher point so as to lower the trajectory of its flight, provided, of course, you are skillful enough to do this safely.

4: Air resistance

As shown in Diagram 5, a looping ball carries a forward spin which brings along the air around it. The velocity of the air moving along with the ball is represented by (V) (Diagram 6).
On the other hand, as the ball moves forward it is represented by the air which has a velocity of (V’) relative to the motion of the ball. As a net result, the velocity of air movement on the top of the ball is reduced to V-V’, while that under its bottom is increased to V+V’.

Since the pressure of air varies inversely with the speed of its moment, there is a greater pressure (P) on the upper part of the ball and a smaller pressure (P’) on its bottom part. That is why the ball dips very fast and the range of its flight is shortened, so that the chance of its going out of bounds is lessened.

II. Characteristic Features of Looping Strokes

There is a wide variety of loops but they all fall into three main types: The accentuated loop, the forward-driving loop and the side-spin loop.
These loops are different from one another in the timing of a stroke, the position of racket-ball impact relative to the body, the point of impact on the ball, the direction of the force applied to the stroke and the length of bat swing.
Table 1 shows a comparison between the stroke movements of the three types of loops as practiced by top players at home and abroad.
From this table it may be seen that the stroke movements in the three types of loops are all different. Consequently, they involve the exertion of force of different magnitudes by different muscles. Moreover, even in the course of a single stroke movement the force exerted by a given muscle is constantly changing in magnitude. Hence the problem whether these muscles are displaying their maximum power in each stroke and what kind of stroke movements will give full play to the strength of the muscles. A clarification of this problem will help develop the player’s muscular strength with a definite purpose and so improve the quality of his loops.
In Table 2, shows an analysis of the work done by different joints and muscles in performing the three types of loops. (Note: A complete looping stroke consist of three phases; back-swing, forward swing and recovery. In this article only the first two phases are analysed.)

Analyses:

(1) Backswing of the bat

The backswing in all the three types of looping strokes involves an extension of the shoulder and elbow joints and the stretching of the working muscles – a process that will reflexively enhance the contractive strength of these muscles so that a greater force can be applied on the ball.
Generally speaking, the muscles should be stretched to the point where the elbow joint is almost straightened.
A bent elbow would prevent the muscles from stretching fully and reduce the distance for building up the speed of the bat swing.
This would be disadvantageous to the full use of muscular strength and the attainment of a satisfactory linear speed in the bat swing. A fully straightened elbow, on the other hand, would cause undue tension in the extensors and adversely affect the contraction of the flexors. That is why the players should have been asked to keep their arm naturally relaxed in their backswing.

The spin of the ball is related to the speed of the arm swing, ($M=\frac{\omega I}{t}$).
The length of the arm swing is a factor contributing to the speed of arm swing. Under given conditions, the greater the length of the arm swing, the greater the increase in the speed of the arm swing.
As shown in Table 1, a looping stroke (particularly a forward-driving one) involves a longer backswing and, relatively speaking, a greater speed of the bat swing (ω), thereby imparting a greater force to the loop.

(2) Forward swing of the bat

From Table 2 we can see that, although the stroke movement in the three types of loops are different, they involve partially the same major muscle groups (except in the case of sidespin loops which involve the action of muscles in the forearm), only that these muscles work at different times and exertion levels.
However, they recruit different minor muscle groups, e.g., biceps brachialis (long head) in accentuated loops and coracobrachialis in forward-driving loops.
In developing strength, therefore, both the major and minor muscle groups should be given adequate attention if we are to produce high quality loops.
When swinging the bat forward for a looping stroke, we first flex the shoulder and elbow joints and then turn the wrist in the radial direction so as to achieve a higher linear speed for the movement of the upper limb. As we know, an object revolving around a fulcrum carries a linear speed, i.e., $V=\omega R$.
When we bend our arm in a stroke movement, we attain a linear speed V_1 by revolving our upper arm around the shoulder joint, V_2 by revolving our forearm around the elbow joint, and V_3 by turning our wrist in the radial direction. (See Diagram 7.)
These combine to produce a linear speed of [V].
If we dispense with the flexion of the wrist, we get a combined speed of [V’]. which is evidently smaller than [V].
So, we can see that the wrist action helps increase the speed of the bat swing. But when should we exert force with our wrist? We know that the biceps brachialis, whose function is flexion of the elbow joint, plays a more important role in producing a looping stroke. It is therefore advisable not to exert force with the wrist until the forearm has displayed its maximum strength.

Generally speaking, a more powerful stroke can be achieved by bringing the wrist into action at the moment of racket-ball impact.
To produce a loop, we usually hit the ball by moving the bat in an inward curve (Diagram 8a) in order to increase the spin of the ball. This is because an inward curve of the bat not only helps to bring about the desired trajectory for the flight of the ball and give full play to the strength of the biceps, but also comes closer to the path of the flight of the ball than does an outward curve (Diagram 8b) and so theoretically speaking lengthens the duration of contact (t) between the bat and the ball (although the increase in the value of (t) is very limited).

When all other factors including the force applied to the stroke are equal, the angular speed ω of the spinning ball hit with the bat moving in an inward curve is greater than when it is hit with the bat moving in an outward curve because $\omega = \frac{FLt}{I}$. Since an outward curve of the bat results in a smaller ω, it can be used to produce a feint loop with moderate spin.

Hitting the ball at the right position relative to the body is highly important because it helps the exertion of force. As we know, the biceps brachialis, one of the matorral muscles for lifting a loop, is connected with both the shoulder and elbow joints. When both of these joints are bent, however, it is impossible to bring the power of this muscle into full play.
As shown in Table 2, the biceps play the main role in bending the elbow joint and a secondary role in bending the shoulder joint. Only by bending the two joints at different times can we give full play to the power of the biceps. And to do so we must hit the ball at the proper position. To produce an accentuated loop, for instance, we should take the ball at a high point about half a meter to the front right of the hip.
If we stand too close to the table to take the ball, we are liable to bend the shoulder joint along with the elbow joint. We must also pay attention to turning our waist with the stroke movement. In this way the shoulder joint will be abducted more than it is flexed, and the simultaneous than it is flexed, and the simultaneous flexing of the shoulder and elbow joints will be avoided.

To sum up, the following points should be observed to produce a more economical and efficient looping stroke: the racket arm in the backswing should be almost straightened and relaxed; to strike the ball, the arm should be bent and the bat should be brought forward in an inward curve while attention should be paid to applying force with the wrist and turning the waist in coordination with the stroke movement. In this way a greater speed is gained for the bat swing and a greater force is generated by the muscles, as conforms with the principles of biomechanics.

III. Suggestions

Based on above analyses, I suggest the following points for improving the looping play:

1. Use your wrist action appropriately in the stroke movement. The linear speed of your hand obtained therefrom will combine with those generated by the action of the shoulder and the elbow. You must of course exert force with your wrist at the moment of impact with the ball so as to give an extra punch to your stroke.
2. Since hitting the ball with the bat moving in an inward curve can increase the spin of the shot and bring about the desired trajectory for the flight of the ball, it is advisable that, after the impact with the ball, you should carry the bat forward in line with the flight of the ball. That would add to effect of friction and increase the angular momentum ($\omega I = Mt$), thus increasing the spin of the ball.

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3. The forward-driving loop is the most powerful of all looping strokes. In specific fitness training, therefore, special attention should be paid to developing those muscles which are involved in performing this kind of loop (See Table 2).
   Using a medium load, you can practice contracting the upper arm (and the forearm along with it) in an explosive way, taking care to relax it after hitting the ball. Such practice will effectively prepare your muscles for the looping play. Other auxiliary exercises like chin-ups, dips on parallel bars and straight-arm side lifts (with dumbbells) are also helpful.

4. Apart from arm movements, a looping stroke places a high demand on the coordination and reflexes of the whole body, including the legs, the waist and the torso. Various methods should be employed to meet this demand. Ballgames like basketball and badminton are recommended.

Conclusion:

As a major style of play the looping game has aroused the attention of more and more people in recent years. Intensive effort has been made to find ways of overcoming it, with initial success.

For the looping players to retain their advantages, it is necessary to make continuous improvement and innovations.

Since various types of loops differ in stroke movements and serve different purposes, it would be fine if a player could mix them together so as to develop a game unmatched by any other styles in many respects- in the degree of spin, forward drive and variation of strokes.

For all its merits, the looping game has its disadvantages, such as the need for a large arm swing in stroke action, which lowers the speed of play. It is therefore necessary to look for effective ways of its movements and develop a kind of a looping technique that is most economical and efficient.

Until the next time, play right.

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