

## IMPACT PHASE KINEMATICS OF KNUCKLING SHOT IN FOOTBALL

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### Introduction

There are many kicking techniques in football, all kicks represent almost same impact time of 1/100 second at the impact between a ball and a foot. Also, such a very short impact time decides the direction of a ball after the interaction between the ball and the foot, but there are still no clear answers for the complex mechanical interaction occurred at the moment of impact between the ball and the foot. In addition, a knuckling shot (knuckle ball or knuckling effect ball) that shows low rotations and spins in a ball for changing the trajectory of a ball as an irregular way has been attracted throughout the world. However, the impact technique between a ball and a foot in such a non-spinning shot is still not well known.

### Methods

We used high-speed video cameras to compare the knuckling shot with the curve shot and straight shot, and investigated the swing characteristics of the kicking leg. Furthermore, the impact process of the kicking foot was analyzed, elucidating the technical mechanism of the knuckling shot.

### Results & Discussion

Hip external rotation in the knuckling shot exerted greater external rotation torque of the hip joint than the other shots, and the tendency to impact with the heel pushed out towards the inside of the foot was considered. Furthermore, ankle joint motion at ball impact in the knuckling

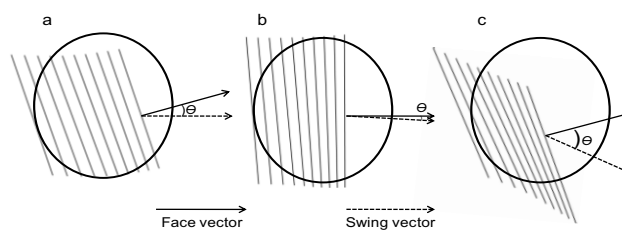


Figure 1. Comparison of average angles of attack in the straight shot (a), knuckling shot (b), and curve shot (c).

shot was thought to be more of a translational motion compared to the other shots. The angle of attack in the knuckling shot was smaller than that in the other shots and was thought to be a factor of a ball with a smaller rotational frequency.

### Conclusion

In the knuckling shot, the reduced angle of attack between the face vector and swing vector at the impact surface, and the primarily translational motion at ball impact, are important and fundamental mechanisms.