The secret to sneaky float serves

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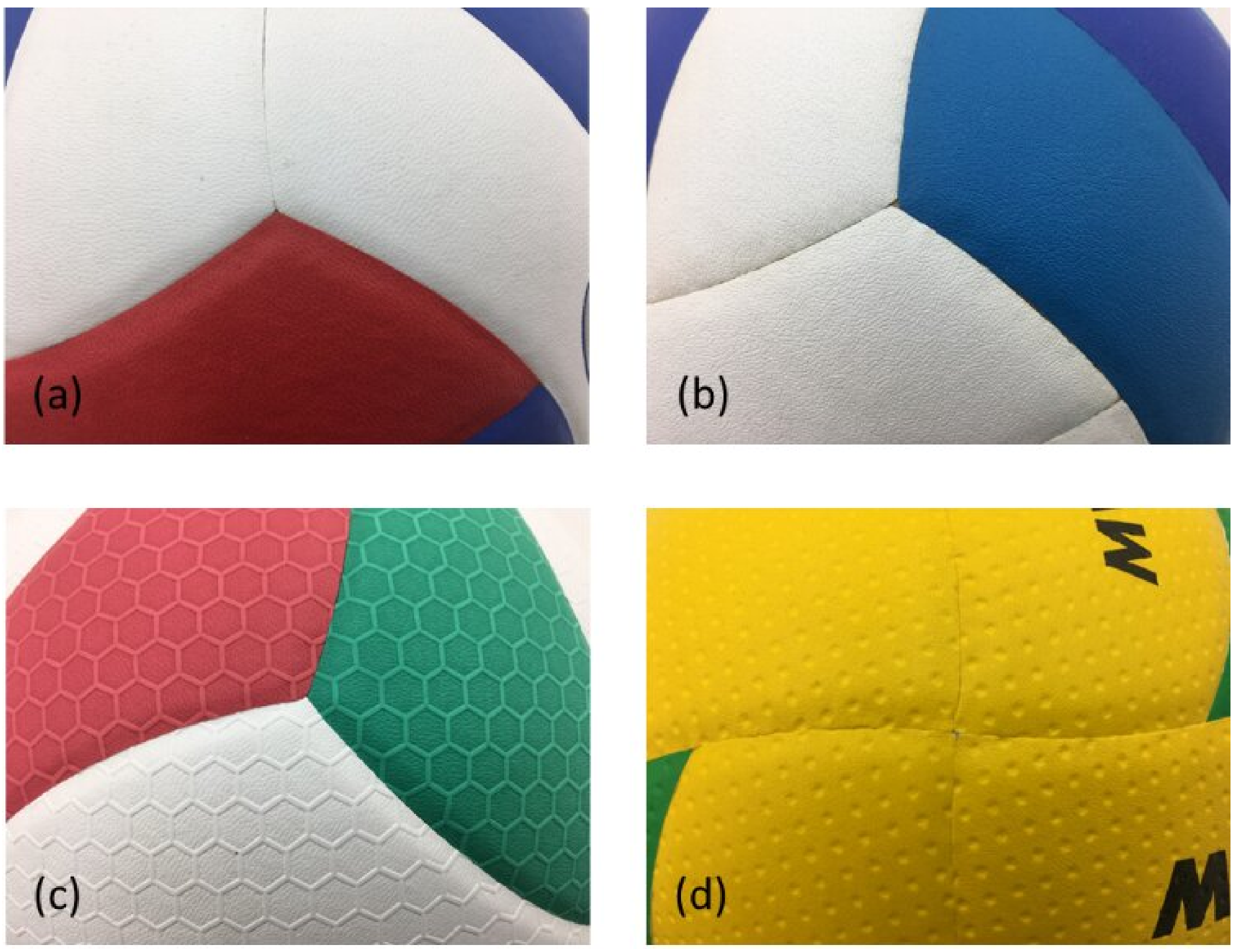

Credit: University of Tsukuba

A research team led by the University of Tsukuba studied the aerodynamics of a volleyball using a wind tunnel and hitting robot. They found that no matter the orientation of a standard ball, the pattern of panels presents an asymmetric surface to the flow of air, leading to deviations in its flight patterns. This work may help shed light on unsolved questions in the field of fluid dynamics.

Aerodynamics, which is the behavior of air as it flows around objects, plays a huge role in many sports. This includes golf, baseball, tennis, soccer, and of course, volleyball. Soccer players can "bend" kicks into the goal, and baseball pitchers throw knuckleballs that can dance around an opposing player's bat. In these cases, the aerodynamic properties are used to gain a competitive advantage. Scientists studying these phenomena tend to focus on the boundary layer of air surrounding the ball. For example, dimples on a golf ball can cause it to fly farther on drives. This is because the dimples reduce drag by creating a turbulent boundary layer of air. But these effects strongly depend on the speed the ball is travelling, as well as the surface roughness.

"When a spherical ball moves through the air, a long tangle of turbulent, swirling air trails behind, causing it to slow down," explains first author Sungchan Hong. "But if the ball is moving fast enough, this wake suddenly shrinks and the drag force plummets in a phenomenon called drag crisis." If the laminar flow of the boundary layer near the ball begins to become turbulent, experienced players can take advantage of the resulting strange aerodynamic effects to make the ball swerve unexpectedly. In particular, a volleyball player can get some extra velocity on his or her float serves with an understanding of these principles.

In the wind-tunnel experiments, the researchers found that the panels on standard volleyballs led to unpredictable flight patterns. They also found a hexagonal pattern in the ball significantly reduces the threshold required for drag crisis to occur, while the dimpled pattern ball increases it. Therefore, this study suggests that the conditions for drag crisis can be controlled with the surface design of a volleyball.

"The most commonly used volleyballs have six panels, each made with three parallel rectangular strips. This makes the trajectory strongly dependent on the orientation of the ball. Using a hexagonal or dimpled pattern instead could significantly increase the consistency of its flight," says author Takeshi Asai. "This research may have important implications not only within sports, but also for developing more efficient and stable drones."

More information: Sungchan Hong et al. Surface Patterns for Drag Modification in Volleyballs, *Applied Sciences* (2019). DOI: 10.3390/app9194007

Provided by University of Tsukuba