A post-COVID-19 proposal to apply artificial saliva substitutes to polish the cricket ball

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Abstract
The COVID-19 pandemic has caused administrators to issue a major change in the playing regulations of cricket. For hygienic reasons, the historic practice of applying saliva to polish one side of the cricket ball has been banned. Fast bowlers feel that this regulation will limit their ability to swing the cricket ball. Wax-like substances have been suggested as a replacement, but the concern is that they may generate excessively high swing forces, unfairly disadvantaging the batters. Instead, we suggest that artificial polishing substances that more closely resemble the properties of saliva, such as alpha-amylase, and mucin-based and Aloe vera-based saliva substitutes could produce swing forces on the ball that are more in keeping with the traditions of the sport. Wind-tunnel experiments will be necessary to develop suitable artificial polishing agents that bowlers can use at all levels of competition.

Keywords
Fluid dynamics, hygiene, sport technique, swing bowling

The COVID-19 pandemic has caused administrators to issue a major change in the playing regulations of cricket, one that potentially reduces the wicket-taking ability of fast bowlers. For hygienic reasons, the historic practice of applying saliva to polish one side of the cricket ball has been banned, so that bowlers must rely exclusively on perspiration to polish one hemisphere of the ball for swing bowling.¹ Fast bowlers feel that this regulation could limit their ability to polish the ball and thus lower the aerodynamic swing forces on the ball, reducing the amount of lateral deviation or swing of the ball in flight.²³ Against fast bowling, the batter must coordinate the body and bat movements within extremely tight time constraints.⁴ However, when the ball swings, changing its course during flight, the batter’s task is further challenged, since a bat with a maximum width of only 10.8 cm must be manoeuvred rapidly and accurately to strike the oncoming ball.⁵ In addition, the later the ball swings in flight the more difficult this task would become for the batter, reducing the time for predictive saccades to make compensatory adjustments,⁶ biasing the outcome in favour of the bowler.

The magnitude and direction of swing force on the ball depends on three main factors: seam angle relative to ball flight, the degree of contrast between the surface textures of the two hemispheres of the ball, and seam stability.⁷ If the bowler releases the new ball with the seam aligned in the direction of the ball’s flight, the flow regimes on either side of the ball will remain the same, and the ball will not swing. However, a sideward swing force is generated if different airflow regimes occur on either side of the ball. Since surface roughness shifts the flow regimes to

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smaller Reynolds numbers, bowlers can generate significant swing forces with relatively new cricket balls by making use of smooth and rough elements on the surface of the cricket ball. The standard method is for the fast bowler to orient the seam at an angle to the ball’s direction of travel so that the seam itself becomes the roughness element on one side, to generate either new-ball conventional swing or reverse swing. It is worth noting that a single ridged roughness element (proud seam) is the ‘roughest’ surface option, rougher than a surface with multiple ridges. Hence, the bowler could polish both hemispheres of the new ball to maximise the effect of the seam as a single roughness element for both conventional and reverse swing.

A progressive problem for bowlers is the deterioration of the ball’s surface during play. As the ball keeps striking the cricket pitch and outfield, both sides of the ball roughen substantially and the seam flattens, reducing the swing force. The rate of roughening depends on various environmental factors, such as the number of balls bowled, pitch hardness and ground surface. Eventually, there will come a time when both hemispheric surfaces attain a critical level of roughness, so that fast bowlers cannot generate swing force through the seam alone. Neither will polishing both sides of the ball be effective at this stage. Instead, to maintain the swing force under such conditions, the bowler polishes one side of the ball to create a contrast in the surface textures between the two hemispheres of the ball, generating what is known as contrast swing.

In fluid dynamics, a boundary layer is a thin fluid layer directly next to a surface formed by the fluid flowing over the surface. A laminar boundary layer is characterised by a fluid flow in layers parallel to the surface, where adjacent layers slide past each other; whereas a turbulent boundary layer consists of circular currents (eddies). In smooth spheres, the transition from laminar to turbulent boundary layer occurs naturally when the flow speed increases, namely during the drag crisis (critical flow regime). Roughness elements on a surface, however, cause the boundary layer to be tripped into turbulence at lower speeds. The main difference between laminar and turbulent boundary layers is that the separation point, where the boundary layer detaches from the surface, happens at smaller angles in laminar flow conditions (on the front hemisphere, 80° from the stagnation point in the subcritical regime), and at greater angles in turbulent conditions (on the back hemisphere, 100°–140° from the stagnation point, in the super- and transcritical regimes). In contrast swing, one side of the cricket ball is polished and the other one is kept rough. As the flow stays longer on the rough surface due to later flow separation, the pressure is smaller than on the other smooth side with earlier separation. The pressure gradient across the two sides produces a sideward force (Magnus force) towards the rough side, causing the ball to swing.

The effect of producing such a pressure gradient is powerful. Contrast swing is a minimally skilful method of generating swing when compared to conventional and reverse swing. The rotation of the seam does not need to be stabilised at an angle relative to the direction of the ball’s flight. The bowler needs only to maintain a relatively stable seam in the direction of the ball’s travel. In contrast swing, the direction and magnitude of swing force rely solely on the speed of the ball and contrast in the surface textures. To assist bowlers in swinging the older ball, ICC Law 42 permits the bowler to polish the ball provided that no artificial substance is used. Since the early days of cricket, when 80–90 stitches raised approximately 1 mm above the ball’s surface were used to stitch together the two leather hemispheres, bowlers and fielders have been applying saliva and perspiration to shine or polish one hemisphere of the ball. Hence, a contrast in surface textures is strategically created to allow the aerodynamic swing force to take effect. This traditional practice has now been restricted since the enforcement of the ‘no-saliva’ ban, which allows only perspiration as the polishing agent. Even though recent unpublished MCC research claims that there has been minimal or no impact on the amount of swing that bowlers were generating since the implementation of an initial temporary ‘no-saliva’ ban, the production and composition of perspiration can vary considerably within and among individuals in response to external conditions, making it a less reliable polishing agent.

The authors believe that the adoption of the new MCC Law banning saliva is justified because SARS-CoV-2 virus can remain infectious on different inanimate surfaces from 2 hours up to 9 days. In addition, there are numerous diseases that can be spread through saliva. The application of saliva to the cricket ball to induce swing is an unhygienic practice — but neither has perspiration been conclusively ruled out as a possible medium for the transmission of SARS-CoV-2: the presence of SARS-CoV-2 in sweat glands and its shedding may occur relatively late in the infectious cycle. Moreover, perspiration can serve as a medium to spread other diseases among sporting participants. In cricket, risk of infection should be considered seriously, since unclean hands with small breaks or cuts in the skin that are exposed to a dirty ball continually lubricated with the perspiration from numerous players throughout the day amounts to a fundamental lack of hand hygiene. Consequently, the MCC Law could go further and ban the application of perspiration as well, but that would terminate the classic art of swinging the old ball.

To mitigate this problem, some players have suggested the introduction of artificial substances, such as wax, to polish the ball. There is, however, the real possibility that such substances would polish the ball to an extent that far exceeds the application of human sweat and perspiration, resulting in increases in swing force that excessively
advantage the bowler and upset the balance in the contest between bat and ball. Conceivably, a fairer solution would be to use artificial substances that are derived from natural human saliva or perspiration. The application of such substances on the ball may be less likely to cause sideways swing beyond the usual amounts observed in cricket matches.

Various artificial saliva and perspiration products are on the market, both for industrial and cosmetic uses. Both artificial saliva and artificial sweat can be made to resemble natural saliva and sweat in their biochemical and physical properties. For instance, the SCIN artificial sweat has been designed to resemble in vivo human axillary sweat. Bowlers have generally considered saliva to be a more effective substance for cleaning and polishing the ball than perspiration, speculating that the judicious application of the former substance has an enhanced ability to increase the swing force.2 There may be some justification of this practice: a superior cleaning effect could result from the action of the enzyme alpha-amylase, a major digestive enzyme in human saliva, that begins the digestion of food by breaking down starch in the mouth.23 Hence, industrially produced alpha-amylase may be a feasible candidate as a saliva substitute, because it can be produced economically in bulk, and the microbes are relatively easy to modify to achieve the desired characteristics.24 It has also been shown that synthetic versions of alpha-amylase can act as effective cleaning agents in the industry.25,26 In addition, mucin-based27 and Aloe vera-based saliva substitutes28 could also be candidates as artificial polishing agents, as well as electrolyte-based solutions.

Future research is required to investigate which artificial substances are comparable with human saliva and perspiration by performing wind-tunnel tests on cricket balls to compare their swing force profiles. Initially, testing should be conservative, focussing on artificial substances that mimic the properties of human saliva. However, in principle, any artificial substance that generates similar swing force profiles to human saliva in the wind-tunnel could be considered a potential replacement. In addition, these artificial substances could include a disinfecting agent to further reduce the risk of transmitting disease.14

If compatible substitutes are found, players could polish the ball with artificial saliva-type products in spray bottles during the game. The bottles could remain with the umpire between overs so that the process is regulated. A limit may be imposed on the number of sprays that can be applied to the ball each over. However, a prescribed limit may not be necessary if there is a saturation effect of the substance on the ball’s surface that diminishes the swing force after a certain number of applications. Such a process could mark a further evolutionary step in the regulation of cricket practices, one that would foreseeably need the collaborative effort of experts in cricket biomechanics, fluid dynamics and biomaterials science, as well as require high-performance coaches and bowlers to participate in field tests to ensure that the ensuing legislative practices are fair and maintain the traditional balance of game.

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