All that slipping and sliding on tennis courts prevents injuries: A biomechanics expert explains how

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"Hard courts are very negative for the body. I know the sport is a business and creating these courts is easier than clay or grass, but I am 100% sure it is wrong. I may have to play more on clay than before, but there aren't that many options." So said Rafael Nadal back in 2012 – and several times since – before succumbing to another knee injury in 2018.

Rafa's right. Evidence has been available for decades to suggest that players have fewer knee problems if they play on clay courts rather than hard surfaces over their careers.

Way back in 1979, German researcher von Salis-Soglio showed that top-ranked tennis players had more leg and back injuries after playing on hard courts than on clay.

But that's not because hard courts are hard. It's because they're not slippery enough.

The physics of hard, grass and clay courts

There's a perception that clay courts are less hard. But anyone who has played on a clay court knows that's not quite true – they are pretty firm. And it's easy to do a little experiment to prove it.

A tennis ball bounces higher on a harder court because the court surface compresses less when the ball collides with it. That means less energy is dissipated and the ball bounces *up* with a lot of energy (largely because of its own elasticity).

That energy dissipation is reflective of the "damping" properties of the surface. If you drop a brand new ball from a height of one metre onto either a clay court or a hard court, it will bounce about 60-65cm high.

On a grass court, the ball may only bounce about 35-40cm. This is because both clay courts and hard courts have a low damping coefficient (a measure of the damping effect when colliding with a ball). Grass courts, on the other hand, typically have a much higher damping coefficient.

Nonetheless, damping may be dramatically reduced on worn areas of grass courts, as is comically demonstrated in this (edited) video.

And tennis players spend a lot of time running on this hard, worn part of the court.

A fraction too much friction

So if clay courts (and some grass courts) are also hard and don't have a high damping coefficient, why aren't they also linked with high injury rates?

A study published 31 years ago provides the best answer. Researcher Benno Nigg and a colleague examined injury rates in more than 1,000 tennis players.

They found that painful injuries were five to eight times more likely when playing on high-friction surfaces such as asphalt and some synthetic surfaces than on courts covered with loose sand that allow players to slip and slide.

It was clear that when friction between the shoe and surface was high, so was the injury rate.

This is now a well-known phenomenon. If you are running fast and you want to stop quickly, you have to apply a force to the ground. The ground returns that force to you (for the science buffs among you, that is Newton's third law) to slow you down.

But you can choose to apply a high force for only a

short time or you can apply a smaller force over a longer time and get the same result: stopping.

We tend to slide when friction is lower and this increases the time over which the force is produced, and the peak force is lower. The lower force is less likely to cause injury, so this is a good thing. In fact, players also notice they're less sore after matches, so they recover faster too.

Actually, the effect of surface friction is seen in other common sporting tasks. For example, other researchers showed that injuries are greater in pivoting sports (such as netball or basketball) when surface friction is higher, even when both surfaces (artificial versus wood) were very hard. In this study, the injury rate was double on the artificial surface, which allowed less sliding.

How we choose to move

But there's another reason for the injury-reduction benefit of lower-friction surfaces. On these courts, we "choose" to move with different, and safer, movement patterns during high-intensity, agility-type tasks such as those in tennis.

A great example is provided in a study looking at people experienced in sports that required side-step "cutting" manoeuvres. Cutting manoeuvres are those that require rapid changes in direction.

When tested on different surfaces, sports people were found to land with their knee straighter and more rotated when running on surfaces with higher friction. This is considered to be a serious risk for knee anterior cruciate ligament (ACL) injury during cutting tasks.

So in a nutshell, there are two things that place us at risk of injury when playing on surfaces with high friction: a lack of energy dissipation, plus a difference in how we move (including rapid changes of direction, as occurs in tennis).

Luckily, a lot of effort has been put into improving hard court surfaces.

At this year's Australian Open you'll see players sliding quite well on the Plexicushion surface (made from latex, rubber and plastic particles), which is specially designed to allow players to slide.

It's safer for the players and also fun to watch.