THE IMPACT RELATIONSHIP BETWEEN TENNIS COURT PROPERTIES AND THE PLAYER-SURFACE INTERFACE

[1]Daniella Strauss, [1]Neil Messenger, [1]Andrea Utley, [2]Stuart Miller
[1]University of Leeds, UK; [2]International Tennis Federation, UK.
email: D.N.Strauss@leeds.ac.uk

INTRODUCTION

The relationship between impact and injury is well established [1]. It is therefore pertinent to investigate the impact properties of playing surfaces and the subsequent load experienced during human interaction in tennis. Tennis is played on a variety of court surfaces of which their material properties appears to determine the nature of the game. Additionally, the game presents numerous health and wellness benefits which make tennis an attractive source of physical activity [2]. As the popularity of the game worldwide continues to grow, the demand for court space has risen proportionally and significantly the construction of acrylic courts far exceeds any other court surface. The acrylic court's 'hard' nature may be an influencing factor in the mechanism of injury for tennis players. The aims of this study are twofold; 1) to measure the impact properties of a variety of tennis court surfaces independently of human interaction and 2) to evaluate the impact characteristics of the player-surface interface.

METHOD

Court surface stiffness was measured by the Keros Prima 100 device (Dynast, Denmark). Equipment set up included 2 buffers and a 300mm contact plate with a loading pressure set to 150kPa. This arrangement was deemed the most appropriate representation of human movement. Three court types where assessed (acrylic, clay and grass), 50 locations were tested across the court surface and 3 trials at each location were performed. Human interface data was collected using in-shoe pressure insoles (Pedar X, Novel gmbh, Germany). Twenty tennis players of varying ability and experience (48:52 male to female ratio; mean age 23.18yrs ±8.78) completed 10 trials of a running forehand. The participants were provided with standard tennis footwear. A ball machine was used in order to maintain a consistent feed of the ball. Peak impact forces and loading rate at peak force were derived for each participant. Subsequently mean data were elicited for court surface type and this was subjected to ANOVA and post hoc tests. Prior to testing all participants completed informed consent and where required parental consent was also sought. All testing procedures had received ethical approval.

RESULTS AND DISCUSSION

Traditionally, impact properties of sports playing surfaces have been measured by the Berlin Artificial Athlete (developed by: FMPA Stuttgart Otto-graf-Institute) which is recognised as the gold standard testing apparatus. However, it has a number of limitations which deem it unsuitable for all sports surface types particularly the 'softer' tennis court surfaces of clay and grass. From the results presented in table 1 the Keros Prima 100 device has been found to be a suitable alternative to the Berlin Artificial Athlete, as Keros Prima 100 device was able to distinguish between court types without causing damage to the playing surface. Additional advantages of this apparatus include its ease of use and its portability. The results suggest that the acrylic court has the greatest stiffness of all tested surfaces, being three times stiffer than the clay court and thirty three times stiffer than the grass court.

Table 1: Summary of impact data from material and human interaction tests

Court Type	Stiffness* (EMa)	Mean Peak Force** (BW)	Mean Loading Rate ($BW \cdot s^{-1}$)
Acrylic	639.0 ±157.0	2.0 ±0.2	76.1 ±19.1
Clay	181.2 ±39.2	1.8 ±0.2	72.3 ±12.7
Grass	19.33 ±9.1	1.7 ±0.2	77.5 ±18.9

* The measures of stiffness for each of the 3 court surfaces are statistically significant (F=478.66, P=0.00).
** The mean impact force recorded on the acrylic courts was significantly different to the grass court but not the clay court surface (F=5.22, P=0.01).

The data collected from the participant trials were normalised to body weight (table 1). As expected the peak impacts recorded on the 'hard' acrylic courts (2.05BW) were significantly higher than the mean impact on the 'soft' grass court surface (1.78BW). However, when these differences are compared to the magnitude of difference found in the material tests the human interface data is far less dramatic. This trend continues with respect to the mean peak loading rate which indicates no difference in peak loading between the surface types. In order to consider these unexpected findings further exploration of the individual differences experienced by the participants is required and most certainly further research regarding the locomotive strategies deployed by players on different court types needs considerable attention.

CONCLUSION

The Keros Prima 100 device provided a measure of the impact properties of the court surfaces. The acrylic court was found to be significantly stiffer than any other court surface. The player-surface peak impact forces are higher for acrylic courts than any other surface type. The discourse between the scale of differences between court hardness and player-surface impact is currently unexplained.

REFERENCES

1. Nigg BN, et al. *Int J Sp Biomech* **2** (3):156-165, 1986
2. Strauss DN, et al. Proceedings of TST3, Roehampton, UK, 193-198, 2007