INJURY & PERFORMANCE ON TENNIS SURFACES

The Effect of Tennis Surfaces
On the Game of Tennis

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November, 2003

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Introduction

Tennis is played on many different surfaces including clay, synthetic surfaces, asphalt, carpet, and synthetic grill. Some of these surfaces are used for high-end tennis competition (e.g. clay, grass, synthetic surfaces), and others primarily for recreational use (e.g. asphalt, carpet, concrete, synthetic grills).

It is commonly speculated that playing surfaces have an effect on performance as well as on the frequency and type of injuries. Until now, however, the current knowledge has not been summarized to provide conclusive evidence for these speculations.

The purpose of this paper is to summarize the current knowledge of the effect of tennis surfaces on the game of tennis and on the frequency of surface-related injuries.

Effects of Playing Surfaces on the Game of Tennis

The effects of surfaces on the game of tennis have been analyzed in a few studies:

2001: *O'Donohue & Ingram*

Study: Compared four different surface types (synthetic grass - Australian Open; clay - French Open; natural grass - Wimbledon; synthetic hard court - US Open) during Grand Slam tournaments between 1997 and 1999.

Finding: Showed that the clay surface resulted in significantly longer rallies than the other three surfaces. Furthermore, found that the horizontal velocity of the ball after ground contact was slower on clay, resulting in less shots per time interval.

1998: *O'Donohue & Liddle*

Study: Compared games on natural grass in Wimbledon with games on clay during the French Open in 1996.

Finding: Showed that the rallies were significantly longer on clay than on natural grass.

1993: *Huges & Clarke*

Study: Compared rallies on natural (Wimbledon) and synthetic grass (Australian Open).

Finding: Showed that rallies on synthetic grass lasted longer and that the serve was more dominant on natural grass.

Summary: Tennis games on clay are characterized with slower ball speed and longer rallies compared to games on natural grass. The games on synthetic grass and synthetic hard court are between the two extremes (clay and natural grass), but closer to natural grass than to clay. Consequently, skills like power, strategy, speed, and precision are required on all surfaces.

RESULT	You should expect a higher aerobic benefit for the players on clay surfaces.
REASON	Rallies on clay last longer so the demand on endurance is typically higher.

Effects of Playing Surfaces on Surface-related Injuries and Pain

Tennis injuries include the upper extremities, the spinal areas, and the lower extremities. This summary concentrates on injuries to the lower extremities.

In most cases, injuries to the lower extremities are surface related.

The few facts published on this topic include:

- 21% of tennis injuries requiring medical treatment were due to uncontrolled slipping, based on data from a retrospective study on all commonly used tennis surface types. *(Biener & Caluori – 1977)*
- Senior players reported fewer knee problems when they had played predominantly on clay courts, compared to senior players who played predominantly on hard surfaces. *(Kulund et al – 1979)*
- Fifteen top-ranked tennis players had more back and lower extremity injuries when playing on hard courts than when playing on clay. *(von Salis-Soglio – 1979)*
- Knee injuries made up 19% of all of the US national teams total injuries. *(Renström – 1995)*
- Lower extremity injuries on a hard court were twice as frequent as either upper extremity or central body injuries during the US National Boy's Tennis Championship from 1986 to 1988. *(Hutchinson et al. – 1995)*
- Overuse injuries were the major cause of tennis injuries followed by muscle or ligament sprains. Note that overuse injuries are primarily influenced by the intensity and duration of activity. *(Bylak & Hutchinson – 1998)*

Most publications on tennis injuries are based on anecdotal clinical and/or coaching observations (e.g. Kulund et al. – 1975; Reece et al. – 1986; Lehmann – 1988; Smith & Tao – 1995).

Lower Extremities Injuries on Different Playing Surfaces

Comparative data on tennis injuries in the lower extremities on different playing surfaces were provided from a retrospective study including six different surface types. *(Nigg & Denoth – 1980; Spiess & Hasenfratz – 1980; Nigg & Segesser – 1988)*

This study has the most comprehensive data set of all the known studies in the literature and will, therefore, be described in detail.

The surfaces included in the study were:

A	Clay	The European version of clay, called "Sandplatz."
B	Synthetic Sand	A synthetic surface with loose granules on top of the surface that allowed controlled sliding.
C	Synthetic Surface	The same synthetic surface as in B with no loose granules.
D	Asphalt/Concrete	Asphalt and concrete surfaces that were used for tennis activities.
E	Felt Carpet	Indoor facilities where a concrete surface was covered with a felt carpet.
F	Portable Synthetic Court	Portable synthetic surface in elements of about 1 square foot, constructed in a grill-like structure, about ½ inch thick, laid without anchoring on an asphalt or concrete base.

The study was based on a questionnaire where tennis players answered questions during two winter and one summer seasons. One tennis player for one season was treated as one "case." In total, 2,481 cases were evaluated.

The results of this questionnaire study showed:

- 52.6% of all cases (one subject during one season) had pain and/or injuries at least once per season.
  - 653 (40%) for the upper body (arms, head, trunk and upper back)
  - 990 (60%) for the lower extremities and the lower back
- Age was not a significant factor for the frequency of pain and/or injury.
- On average, the subjects played 4.07 hours per week. There was an increase of injuries with increasing playing time.
- The frequency of pain and/or injuries was different for the six surface types included in the study. *(absolute and relative to exposure per week - Table 1)*
  - Clay had the lowest frequency
  - Synthetic sand had the second lowest frequency
- The injury frequency for clay and synthetic sand were significantly lower than the injury frequencies of the other four surfaces (synthetic surface, asphalt/concrete, felt carpet, synthetic grill). <u>The differences were not only significant, they were substantial.</u>

Injury frequencies were 4 to 8 times smaller for clay than for the four surfaces that did not allow any sliding. *(Table 1)*

TABLE 1 Frequency of Injury and Pain For Six Surface Types

Second column: Frequency of injury and pain
Third column: Comparison of the injury frequency to the frequency of clay
Fourth Column: Frequency of pain and injuries as it relates to the exposure in hours per week

Surface	Frequency (%)	N(surface) / N(clay)	Relative Frequency [% / hour / week]
Clay	**2.2**	**1.0**	**0.5**
Synthetic Sand	3.0	1.4	1.6
Synthetic Surface	10.7	4.9	3.0
Asphalt/Concrete	14.5	6.6	3.9
Felt Carpet	14.8	6.7	4.8
Synthetic Grill	18.0	8.2	2.2

Different Factors May be the Reason for this Result

- **Traction and safety:** The tested surfaces had substantially different translational traction coefficients. The translational traction coefficients are substantially lower on clay and synthetic sand (about 0.5 – 0.7) than on the surfaces where sliding does not occur (about 0.8 – 1.2). Traction coefficients between shoe and surface that are below 0.4 produce situations where slipping can occur. Thus, the combination of surface and shoe must be optimized.

> ***It has been shown for general surfaces that traction coefficients between about 0.4 and 0.7 are most comfortable and safest.*** *(Yoshioka et al. – 1979)*

- **Internal loading:** It has been shown that the vertical ground reaction forces were about three times higher on felt carpet than on clay. *(Tiegermann – 1984)* Furthermore, the muscle activity (peroneus EMG) was much higher on felt carpet than on clay. Thus, the loading situation is substantially higher on felt carpet than on clay.

> ***Results of these studies suggest that loading of the locomotor system is lower on surfaces that do allow sliding (i.e. clay and synthetic sand) compared to surfaces that do not allow sliding (i.e. synthetic surface, asphalt/concrete, felt carpet, synthetic grill).***

Summary

- ✓ **Pain and/or injuries are substantially lower on tennis surfaces that allow sliding (clay and synthetic sand) compared to surfaces that do not allow sliding.**
- ✓ **Muscle activity in the lower extremities is lower for surfaces that do allow sliding.**
- ✓ **The loading of the lower extremities is smaller on surfaces that allow sliding than on surfaces that do not allow sliding.**

Researcher

Dr. Benno M. Nigg is one of the world's leading authorities on the biomechanics of playing surfaces. He is the director of the Human Performance Laboratory of the University of Calgary, and has organized six international symposia on sport surfaces. The Human Performance Laboratory is a multidisciplinary Research Institute with about 100 co-workers. It has been ranked by external reviewers as "the best in the world in Clinical Biomechanics research." Members of the Human Performance Laboratory have been awarded numerous international and national awards.

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