The influence of court surface impact properties on the loading response in tennis players

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Introduction

• “Impact experienced is thought to influence movement strategy and injury potential”

• Development of suitable test procedures
  – Out of the lab

• An example – tennis
  – Various surfaces (nature of the game)
    • Knowledge of ball-surface interface
  – Movement (multidirectional)
  – Material tests (attempt to consider vertical and shear loads)
Material testing *in vivo*

- Difficulties with measuring court surface friction
- Equipment available
  - Tortus II (dynamic friction)
  - Traction meter (traction)
  - TRL pendulum (limiting friction)
- Results
  - Unsuitable for all surface types
Material testing *in vivo*

- Keros Prima 100 device (Dynatest UK Limited)
- Distinguish between court types
  - ‘same’ protocol
    - **Drop height** (no effect of impact stiffness but height effects contact pressures; greater drop height = greater impact pressure)
    - **Buffers** (effects impact pulse time but not recorded stiffness)
    - **Loading plate** (plate size effects stiffness; smaller plate = greater stiffness) link to human action
  - **No damage**
Significant difference between court types

Surface maps suggest trends possibly in relation to human traffic

2 buffers, 300mm plate, average of 3 drops

Acrylic Court
Stiffness Range 300-940 EMa

Clay Court
Stiffness Range 50-250 EMa

Grass Court
Stiffness Range 5-50 EMa
Human Performance testing *in vivo*

- No *in vivo* method to measure shear force components
- Pedar X (Novel gmbh, Germany)
  - Matrix insoles
  - Normal force
- Protocol
  - 17 subjects with ranging ability
  - 2 movements, 10 trials each
  - 3 surfaces, 2 shoes
  - Variables
    - Velocity
    - Peak Impact
    - Maximum loading rate
    - Pressure distribution
Human Performance: understanding movement
Loading Response

![Graphs showing peak impact force and loading rate for different conditions and court surfaces.]

**Peak Impact Force (BW)**
- Acrylic
- Clay
- Grass
- General Court Shoe
- Specific Court Shoe

**Loading rate (BW⁻¹)**
- Acrylic¹
- Clay
- Grass²
- General Court Shoe
- Specific Court Shoe
Conclusions

• The Keros Prima 100 device provided a measure of the impact properties of the court surfaces.
  – a useful addition to surface testing equipment, particularly with reference to the information provided by ‘surface maps’

• The acrylic court was found to be significantly stiffer than any other court surface.
  – 3 and 33 times stiffer than clay and grass courts respectively.

• Maximum forces experienced by players are generally higher on acrylic courts than any other surface.

But
• Not in parallel to the magnitude of difference between the stiffness displayed by the surfaces.
• Loading rates appears to be independent of surface type.
• The discourse between the scale of differences between court hardness and player-surface impact is currently unexplained.
Thank you & time for questions