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Research article

The Effects of Racket Inertia Tensor on Elbow Loadings and Racket Behavior for Central and Eccentric Impacts

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ABSTRACT

This paper discusses the inertia tensors of tennis rackets and their influence on the elbow swing torques in a forehand motion, the loadings transmitted to the elbow from central and eccentric impacts, and the racket acceleration responses from central and eccentric impacts. Inertia tensors of various rackets with similar mass and mass center location were determined by an inertia pendulum and were found to vary considerably in all three orthogonal directions. Tennis swing mechanics and impact analyses were performed using a computer model comprised of a full-body model of a human, a parametric model of the racket, and an impact function. The swing mechanics analysis of a forehand motion determined that inertia values had a moderate linear effect on the pronation-supination elbow torques required to twist the racket, and a minor effect on the flexion-extension and valgus-varus torques. The impact analysis found that mass center inertia values had a considerable effect on the transmitted torques for both longitudinal and latitudinal eccentric impacts and significantly affected all elbow torque components. Racket acceleration responses to central and eccentric impacts were measured experimentally and found to be notably sensitive to impact location and mass center inertia values.

Key words: Biomechanical models, tennis swing, forehand, elbow loads, impact behavior

Key Points

- Tennis biomechanics.
- Racket inertia tensor.
- Impact analysis.
- Full-body computer model.