ECCENTRIC LOADING AND UPPER LIMB MUSCLE–BONE ASYMMETRIES IN ELITE TENNIS PLAYERS

Dear Editor-in-Chief

We read with interest the comprehensive and excellent study "Upper limb muscle–bone asymmetries and bone adaptation in elite youth tennis players" by Ireland et al. (2). One of their most important findings was a strong relationship between muscle and bone size in both arms, but a surprisingly higher bone–muscle ratio in the upper arm of the racquet arm (20%–50% higher as per their Fig. 3) compared to the contralateral arm.

Having reviewed their data and results, we would like to expound on the possible cause for these findings. Muscles can resist forces via eccentric and isometric muscle activation significantly greater than they can generate via concentric muscle activation (1,3). Whatever the peak power and force might have been for a particular subject in the study for a press-up, it would have been substantially higher for the reverse maneuver performed from a standing height, namely a plyometric drop onto the platform with the arms held up front to brake the fall. With maximal eccentric muscle activation of a particular muscle or muscle group, the forces, torques, and stress on bone would be much higher than with concentric muscle activation.

As Ireland et al. indicated, in tennis, a large impulse is imparted to the ball over a short period, resulting in a high level of force. The impulse occurs as a result of a collision between the racquet and ball when the racquet and ball are traveling in opposite directions at high speed. The kinetic energy of this collision is disproportionately higher than would be produced by the player's arm muscles alone because the racquet would have been accelerated by multiple muscles in the kinetic chain of the arm, shoulder, trunk, and lower extremities, and the ball would have been accelerated by the opposing player. The impulse and force from this collision is eccentrically or isometrically resisted by racquet arm muscles and transferred to the bone. The stress on the bone is correspondingly higher than predicted on the basis of arm muscle cross-sectional area with subsequent bone adaptations producing the higher bone–muscle ratio seen in the upper arm. If our analysis is correct, then a recommendation from the current study would be to include eccentric muscle activation in strategies to prevent bone loss in populations at risk.

Another interesting finding of the study was the significant increase in periosteal circumference noted in the radius and humerus of the racquet arm compared to the contralateral arm. While this enlargement of the humerus is without apparent negative effect, a similar enlargement of the femur at the femoral head–neck junction could potentially contribute to femoral–acetabular or hip impingement. It would be interesting to know if the bone adaptations seen in elite young tennis players persist or regress back to normal once players retire from intensive training. If so, strategies at reducing certain types of loading in activities at risk for hip impingement might be effective in slowing down the progression if not reversing the course of disease.

Marko Bodor, MD
Department of Physical Medicine and Rehabilitation
University of California Davis, Davis, CA
Department of Neurological Surgery
University of California San Francisco, San Francisco, CA
Interventional Spine and Sports Medicine
Napa, CA
mbodormd@sbcglobal.net

Renata Jarosz, DO
Interventional Spine and Sports Medicine
Napa, CA

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