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## **ARTICLES**

## The Influence of Biomechanical Factors on Belle Piked Highly Executed Gymnastic Performance on the Parallel Bars

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### ABSTRACT

The purpose of this study was to identify the correct technique to perform highly executed long swing gymnastic movement: Belle Piked (BP). Two national Chinese gymnasts (58kg, 60.3kg) performed 4 repetitions of BP movement, on the middle of parallel bars with zero deduction. Reflective markers (14mm) and ten high-speed cameras (ViconT40S, 100Hz) were used to observe the time history of attached markers on the Humeral head and Cervical Vertebra (C7). The coordinates of the necessary markers were observed using ViconT40S digitizing software. Standard Lagrange dynamic equations were used to derive the dynamic equations of Arm. The average stiffness coefficient of the shoulder joints ( $K_{S,Avg} = 31,670 \text{ N.m}^{-1}$ ) was estimated through the model of the shoulder. The reaction on the Humeral head ( $R_{S,Avg} = 196.14 \text{ N}$ ) under the bars (angular displacement of C.G is  $180^\circ$ ) is significantly lower than the other places of the movement pattern. Also, the direction of acceleration of the Humeral head ( $-2.88 \text{ m.s}^{-1}$ ) implied that the player moves the body upward with respect to the C7. The range of muscle torque around the shoulder joint is  $-10.8 \text{ N.m} < \tau_s < + 18.2 \text{ N.m}$ . Though the angle of the head and neck segment with the vertical axis is nearly zero at the bottom of the bars, the gain of elastic energy from bars was optimized (122.75 J for 58 kg player). Therefore, optimum values of these biomechanical factors are influenced to promote BP movement on the parallel bars with zero execution errors.

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