

# 新编太极弹力带功法开合动作与弹力带抗阻训练反飞鸟动作的生物力学特征比较分析

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**摘要:** **目的:** 太极弹力带功法是根据《太极心脏康复方案》中“太极运劲功”改编而来, 近年来被用在冠心病患者身上, 对提升患者运动能力具有显著效果。本研究采用运动生物力学方法进行分析, 实验时选取太极弹力带功法中具有代表性的开合动作与弹力带抗阻训练动作中动作外形相似的反飞鸟动作进行对比分析, 探究两者在动作外形和肌肉用力方面的生物力学特征差异, 以期发现太极弹力带功法自身独特的生物力学特征, 寻找太极弹力带功法的优势, 进而为太极弹力带功法在太极拳健康干预中的应用提供理论支撑。**方法:** 在北京师范大学招募 26 名男性受试者, 按照 1:1 的比例随机分为两组, 太极弹力带功法组 13 人, 弹力带抗阻训练组 13 人。采用 Vicon 红外动作捕捉系统采集运动学数据。运用 AnyBody 软件计算关节角度、关节角速度、肌肉力、肌肉激活度和关节力指标。使用 Delsys 软件采集表面肌电数据, 并通过软件配套的 EMG works Analysis 分析软件计算出均方根振幅值。使用 SPSS20.0 软件对数据进行处理, 在文章中使用平均数±标准差 ( $\bar{X} \pm S$ ) 来描述实验的各项指标数据,  $P < 0.05$  代表有显著性差异,  $P < 0.01$  代表有非常显著性差异。**结果:** (1) 关节角度: 太极弹力带功法组的肩关节水平外展角度非常显著小于弹力带抗阻训练组 ( $P < 0.01$ ); 太极弹力带功法组的肘关节屈曲角度非常显著大于弹力带抗阻训练组 ( $P < 0.01$ ), 太极弹力带功法组膝关节屈曲角度非常显著大于弹力带抗阻训练组 ( $P < 0.01$ )。 (2) 关节角速度: 太极弹力带功法组的肩关节水平外展角速度显著小于弹力带抗阻训练组 ( $P < 0.05$ )。 (3) 最大肌力: 太极弹力带功法组的肱二头肌最大肌力非常显著大于弹力带抗阻训练组 ( $P < 0.01$ ); 太极弹力带功法组的喙肱肌最大肌力显著大于弹力带抗阻训练组 ( $P < 0.05$ )。 (4) 肌肉激活度: 太极弹力带功法组的肱二头肌肌肉激活度显著大于弹力带抗阻训练组 ( $P < 0.05$ )。 (5) 平均肌力: 太极弹力带功法组的冈下肌平均肌力、喙肱肌平均肌力、肱二头肌平均肌力、肱肌平均肌力和肱桡肌平均肌力非常显著大于弹力带抗阻训练组 ( $P < 0.01$ ), 太极弹力带功法组喙肱肌平均肌力非常显著大于弹力带抗阻训练组 ( $P < 0.01$ ), 太极弹力带功法组肱二头肌平均肌力非常显著大于弹力带抗阻训练组 ( $P < 0.01$ ), 太极弹力带功法组的肱肌平均肌力非常

显著大于弹力带抗阻训练组 ( $P<0.01$ )，太极弹力带功法组的肱桡肌平均肌力非常显著大于弹力带抗阻训练组 ( $P<0.01$ )。(6) 标准化 RMS: 太极弹力带功法组的三角肌前部标准化 RMS 均小于弹力带抗阻训练组 ( $P<0.01$ )，太极弹力带功法组的肱三头肌的标准化 RMS 均小于弹力带抗阻训练组 ( $P<0.01$ )，太极弹力带功法组的三角肌后部的标准化 RMS 小于弹力带抗阻训练组 ( $P<0.05$ )。**结论:** (1) 与弹力带抗阻训练的反飞鸟动作相比，太极弹力带功法开合动作具有肩关节水平外展幅度小、角速度小、肘关节屈曲和膝关节屈曲角度大的特点，动作外形具有“圆弧”的特征，具有匀速缓慢，关节力值较大的特征。(2) 与弹力带抗阻训练的反飞鸟动作相比，太极弹力带功法开合动作具有肩关节和肘关节最大肌力和肌肉激活度较低、肩关节水平内收肉发力不均衡、肘关节屈肌平均肌力较大和安全性高的特征。(3) 与弹力带抗阻训练的反飞鸟动作相比，太极弹力带功法开合动作具有标准化 RMS 值较小的特征。(4) 建议将太极弹力带功法应用于老年人、儿童或肌肉力量水平较低的人群中。

**关键词:** 太极弹力带功法; 弹力带抗阻训练; 仿真

## **Comparative analysis of biomechanical characteristics of the opening and closing movements of the new Tai Chi elastic band exercise and the anti-bird movements of the elastic band resistance training**

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**Abstract: Objective:** Taiji elastic band exercise is adapted from the "Taiji movement strength exercise" in the "Taiji Cardiac Rehabilitation Program", which has a significant effect on improving patients' exercise ability. This study uses the exercise biomechanics method to select the representative opening and closing movements of Taiji elastic band exercise and the anti-bird movements with similar shapes in the resistance training movements of Taiji elastic band exercise for comparative analysis, to explore the differences in biomechanical characteristics of the two in terms of movement shapes and muscle strength, in order to find the unique biomechanical characteristics of Taiji elastic band exercise itself. To find the advantages of Taiji elastic band exercise, and then provide theoretical support for the application of Taiji elastic band exercise in

Taiji health intervention. **Methods:** 26 male subjects were recruited and randomly divided into two groups according to the ratio of 1:1:13 in the Tai Chi elastic band exercise group and 13 in the elastic band resistance training group. Kinematic data were collected by Vicon infrared motion capture system. AnyBody software was used to calculate joint Angle, joint angular velocity, muscle force, muscle activation and joint force indicators. SPSS20.0 software was used to process the data. In this paper, the mean  $\pm$  standard deviation ( $\bar{X} \pm S$ ) was used to describe the experimental indicators.  $P < 0.05$  meant that there was a significant difference, and  $P < 0.01$  meant that there was a very significant difference. **Results:** (1) Joint Angle: The horizontal abduction Angle of shoulder joint in Tai Chi elastic band exercise group was significantly lower than that in elastic band resistance training group ( $P < 0.01$ ); The elbow flexion Angle and knee flexion Angle in the Tai Chi band exercise group were significantly higher than those in the band resistance training group ( $P < 0.01$ ). (2) Joint angular velocity: The horizontal abduction angular velocity of the shoulder joint in the Tai Chi elastic band exercise group was significantly lower than that in the elastic band resistance training group ( $P < 0.05$ ). (3) Maximum muscle strength: the maximum muscle strength of biceps in the Tai Chi elastic band exercise group was significantly greater than that in the elastic band resistance training group ( $P < 0.01$ ); The maximum muscle strength of coracobrachial muscle in Tai Chi elastic band exercise group was significantly higher than that in elastic band resistance training group ( $P < 0.05$ ). (4) Muscle activation: The biceps muscle activation in the Tai Chi elastic band exercise group was significantly greater than that in the elastic band resistance training group ( $P < 0.05$ ). (5) Average muscle strength: The average muscle strength of infraspinatus muscle, coracobrachialis muscle, biceps muscle, brachialis muscle and brachioradialis muscle in Tai Chi elastic band exercise group was significantly higher than that in elastic band resistance training group ( $P < 0.01$ ). (6) root-mean-square amplitude: The standardized RMS of the anterior deltoid muscle, the posterior deltoid muscle and the triceps muscle of the Tai Chi elastic band exercise group were lower than those of the elastic band resistance training group ( $P < 0.01$ ), the standardized RMS of the posterior deltoid muscle of the Tai Chi elastic band exercise group was lower than that of the elastic band resistance training group ( $P < 0.05$ ). **Conclusion:** (1) Compared with the anti-bird action of the elastic band resistance training, the opening and closing action of Taiji elastic band exercise has the characteristics of

small shoulder joint horizontal abduction amplitude, small angular speed, large elbow joint flexion Angle and knee joint flexion Angle, and the shape of the action has the characteristics of "circular arc", with uniform slow speed and large joint force value. (2) Compared with the anti-bird action of elastic band resistance training, the opening and closing action of Tai Chi elastic band exercise has the characteristics of lower maximum muscle strength and muscle activation of shoulder joint and elbow joint, uneven horizontal adduction force of shoulder joint, larger average muscle strength of elbow flexor muscle and high safety. (3) Compared with the anti-bird action of elastic band resistance training, the opening and closing action of Tai Chi elastic band exercise has the characteristics of smaller standardized RMS value. (4) It is recommended to apply Taiji elastic band exercise to the elderly, children or people with low muscle strength level.

**Key words:** Tai Chi elastic band exercise, Elastic band resistance training, Simulation