THE EFFECTS OF ECCENTRIC PHASE DURATION ON CONCENTRIC PHASE FORCE PRODUCTION DURING DROP JUMPS

Sandor Dorgo, Ph.D., CSCS, Darla R. Smith, Ph.D., Melchior Ortiz, Ph.D., George A. King, Ph.D., CSCS

ABSTRACT

The purpose of the study was to test the yet unproven theory, which states that the faster a muscle is stretched the greater force it produces in the subsequent concentric phase during plyometric exercises. Thirty-three trained male athletes performed plyometric drop jumps from two heights (trial A: 33.02 cm, trial B: 47.94 cm) landing on a force platform, followed by an immediate counter jump. Researchers determined the duration of eccentric phase and the relative peak concentric force of each jump using the data from the force platform. Results indicated a significant inverse relationship between eccentric duration and relative peak concentric force in both trials (p = 0.019 and p = 0.001). This relationship was stronger as the height of the drop jump increased (r = 0.40 in trial A and r = 0.62 in trial B).

INTRODUCTION

- Plyometrics have been shown to increase explosive power output (4,6)
- Plyometrics are based on the stretch-shortening cycle (rapid eccentric action followed by a concentric action) (4,6,7,9)
- Rapid prestretching provides a more powerful concentric action (1,2,7) due to myotatic reflex (6,9) and stored elastic energy (1,2,7)
- Stored elastic energy is only available if the amortization phase (time between eccentric and concentric phase) is short (2)
- Authors have argued that the faster a muscle is stretched, the greater the concentric force developed (3,5,6,8,9)
- There have been no studies directly investigating this theory

PURPOSE

The purpose of this study was to examine the relationship between the duration of the eccentric phase and the peak force production in the concentric phase of plyometric jumps.

METHODS

1. N = 33 (trained male athletes)
2. Age = 20.36 ± 1.11 years
3. Two drop jumps:
   - from 33.02 cm (trial A)
   - from 47.94 cm (trial B)
4. Immediate maximal vertical jump after landing on force platform
5. Instrumentation – PEAK Motus (60 Hz), AMTI force plate (600 Hz)
6. Relative peak ground reaction forces = peak vertical force/body weight (N/kg)

RESULTS

- Figure 1 – The relationship between the duration of eccentric phase and relative peak concentric force for trial A (33.02 cm, panel a) and trial B (47.94 cm, panel b)
- Trial A and trial B were examined separately
- The relationship between the duration of eccentric phase and relative peak concentric force was found similar for the two trials
- In both cases there was a significant inverse relationship (trial A: r = -0.40, p = 0.0194; trial B: r = -0.62, p < 0.0001), indicating higher relative peak concentric force for shorter eccentric duration

CONCLUSION

Significant inverse relationships were found in both trials between eccentric duration and relative peak concentric force, which provides evidence for the original hypothesis of “shorter eccentric phase producing a more powerful concentric action”. The relationship was significantly stronger in trial B (drop jump from the higher box), which indicates that a faster pre-stretch yielding to a more powerful concentric contraction is more evident in higher intensity plyometric jumps. Overall, a key component to maximizing force production during plyometric exercises is to minimize the duration of the eccentric phase of the movement.

REFERENCES