



# Eccentric Applications for Safe Movement

## Definition

An eccentric muscle contraction is one of two types of isotonic contractions (concentric being the other). A concentric contraction is one in which a muscle shortens as a result of the muscle being able to overcome the external force. During an eccentric movement, the tension generated by a muscle is less than the load placed on that muscle. This creates movement where the muscle lengthens or moves away from its center. Eccentric movements have been understood as far back as the late 1800's when it was found that a muscle could exert greater force when stretched under a load. Furthermore, it was discovered in the 1930's that these contractions create decreased energy liberation in a muscle that is stretched during a contraction.<sup>1</sup> Overall, it has been found that eccentric contractions can generate 40% higher torque and produce greater strength gains compared with concentric exercise. This comes as a result of not producing muscle damage or loss of function.<sup>5</sup>

## Uses in everyday life

Every movement during activity occurs with concentric or eccentric movements. Sitting down in a chair, lowering a coffee mug from the cupboard, walking down steps, and bending over to pick up a box are just a few activities that create an eccentric force on the muscles. Without proper conditioning, these simple tasks can be difficult and potentially have significant impact on a person's quality of life. The "repeated-bout effect" is a fundamental concept in helping to eliminate weak areas of certain muscle fibers with the use of repeated eccentric exercise. Changes occur in the recruitment of motor units with more exposure to eccentric contractions.<sup>2</sup>

## Uses in sports

One of the more commonly known benefits of eccentric exercise is related to sports activities. It has been documented that eccentric exercise causes increased stiffness in the muscle fibers. This increased stiffness results in a tighter muscle spring allowing for more powerful and explosive movements.<sup>3</sup> Athletes wanting to improve their vertical jump, golf swing speed or their first step off the line should expect more benefit from eccentric exercise than traditional concentric strengthening programs. Also, eccentric exercise is a way to better simulate the braking and change of direction forces associated with many sports movements.

## Uses in general orthopedic rehabilitation

Among the many conditions treated in traditional physical therapy and athletic training settings are ACL rehabilitation, Total Knee Replacement, and Hip Arthroplasty. With regards to ACL rehabilitation, an eccentric based program has been shown to be a viable way to create more short term results in strength, performance, and activity level compared with a traditional rehab program.<sup>4</sup> Depending on the procedure involved and the rehabilitation criteria from the prescribing physician, eccentric exercise should be an integral part of ACL reconstruction.

## Uses in the Geriatric Population

The geriatric population can, at times, be a group with limited tolerance to traditional exercise. This can be due to a variety of causes, including cardiovascular or respiratory disease. The work rates needed for gaining strength may be unachievable via traditional concentric exercise. In fact, one can begin exercising at a higher eccentric work rate than concentric work rate. At the same time, the eccentric exercise requires the same or less than the same amounts of oxygen as concentric exercise.<sup>5</sup> Perhaps one of the most beneficial components of eccentric exercise for the elderly is the increased muscle strength and decreased fall risk. Due to the high force production, muscles can make significant adaptations. These strength gains have shown to improve balance, stair decent, and reduce risks for falls.<sup>6</sup>

## Uses in other special populations

Eccentric exercise can be very beneficial for a wide range of patient populations due to the high forces applied with less stress placed on the cardiopulmonary system. Particular groups that will benefit from high volume eccentric exercise are:

- Cancer Survivors
- Parkinson's Patients
- Diabetics
- Bariatric Patients
- Stroke Recovery

## Applications to PrimusRS

PrimusRS is capable of operating in various modes and one of the most common is the concentric/eccentric mode (or con/ecc for short). Another way to utilize the eccentric function is by setting differing forces in the concentric vs. eccentric directions. Set the concentric force low and the eccentric force to be three times higher (1:3 ratio for concentric to eccentric) to provide significant eccentric strength training and plyometric training to increase speed and power. Refer to the Primus Operator's Manual (Section 2.4, *Pg. 207*).

## Applications to Eccentron

The Eccentron is a lower extremity eccentrically focused strengthening device. Many studies have utilized the current model or earlier design models. The platform has been shown to be a safe and effective device for providing eccentric exercise to the lower extremity.<sup>4</sup> The treatment paradigm is designed in a way to mitigate DOMS and muscle injury. Knowing the value of eccentric exercise opens the door for MANY patient populations to significantly benefit from using the Eccentron. Not only can this be used in a traditional rehabilitation manner, it also can be used to better enhance sports performance. As previously stated, eccentric exercise makes muscle fibers stiffer allowing for better explosive movements to be performed. Also, eccentric exercise is shown to improve balance which can reduce the risk of injury.

## Summary

Eccentric exercise can be a very beneficial component of a quality rehabilitation and injury prevention protocol. There are various ways to incorporate more eccentric movements during rehabilitation to better replicate day to day activities. The Primus RS and the Eccentron provide the therapist with objective data to better quantify eccentric strength.

<sup>1</sup> Lindstedt, S.L., LaStayo, P.C., Reich, T.E. When Active Muscles Lengthen: Properties and Consequences of Eccentric Contractions. *News Physiol. Sci.* 16: 256-261, Dec. 2001.

<sup>2</sup> Stauber WT. Eccentric Action of Muscles: Physiology, injury, and adaptations. *Exercise Sport Sci Rev* 17: 157-185, 1989

<sup>3</sup> Seyfarth A, Blickman R, and vanLeeuwen JL. Optimum take-off technique and muscle design for long jump. *J Exp Biol* 302: 741-750, 2000

<sup>4</sup> Gerber J., Marcus, R., Dibble, L., Greis, P., Burks, R., LaStayo, P. Safety, Feasibility, and Efficacy of Negative Work Exercise via Eccentric Muscle Activity Following Anterior Cruciate Ligament Reconstruction. *JOSPT* 37: 10-18, 2007

<sup>5</sup> LaStayo P., Reich, Urquhar, Hoppeler, Lindstedt. *Chronic eccentric exercise: Improvements in muscle strength can occur with little demand for oxygen.* *American Journal of Physiology.* 276: 611-615, 1999.

<sup>6</sup> LaStayo, P.k, Ewy, G., Pierotti, D., Johns, R., Lindstedt, S. *The Positive Effects of Negative Work: Increased Muscle Strength and Decreased Fall Risk in a Frail Elderly Population.* *Journal of Gerontology,* 58A: 37-42, 2003.