

Clinical Strategies for Addressing Muscle Weakness Following Knee Injury



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KEYWORDS

- Disinhibitory modalities • Transcutaneous electrical nerve stimulation
- Transcranial magnetic stimulation • Electromyographic biofeedback

KEY POINTS

- Quadriceps strength may be a major contributor to disability and the progression of chronic joint disease following acute knee injury and in patients with knee osteoarthritis.
- Traditional therapeutic exercise may not target the neuromuscular origins of muscle weakness, leading to persistent strength deficits long after the initial injury and return to activity.
- Augmenting strength training with disinhibitory modalities or by using alternative strengthening techniques may help maximize strength gains from therapeutic exercise-based rehabilitation.

INTRODUCTION

Lower extremity muscle weakness is common following acute and chronic knee joint injury, and often persists long after the injury has occurred. Persistent muscle weakness following joint injury is dangerous because

1. Muscle weakness may negatively affect physical performance, disability, and willingness to engage in physical activity.
2. Muscle weakness may contribute in the progression of acute to chronic joint injury.

This article discusses the emerging evidence and novel rehabilitation strategies for maximizing strength gains following acute knee injury or surgery, and in patients with knee osteoarthritis.

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EVIDENCE FOR PERSISTENT MUSCLE WEAKNESS FOLLOWING KNEE INJURY

Quadriceps muscle weakness is of great clinical concern because the quadriceps is critical for allowing people to complete activities of daily living.¹ Persistent quadriceps muscle weakness has been demonstrated in patients following anterior cruciate ligament (ACL) injury and ACL reconstructed (ACL-R) in subacute phases years after injury.² Quadriceps strength is critical in predicting self-reported disability in younger patients with a history or ACL injury. Quadriceps strength alone predicts 61% of the variance in self-reported function in ACL-R patients, indicating that ACL-R patients with stronger quadriceps are associated with less disability a mean of 4.5 years following surgery.³ Interlimb deficits in quadriceps strength have been reported from less than 1 month and up to 4 years after arthroscopic meniscectomy.⁴ Altered gait biomechanics are common in patients with persistent muscle weakness following acute joint injury.⁵⁻⁷ ACL-injured or ACL-R patients demonstrate more extended or stiffened knee joint angles during walking gait,^{6,8,9} potentially due to the inability to adequately eccentrically activate the quadriceps during the stance phase of gait.¹⁰ A more extended knee at initial foot contact and during midstance of gait may alter proper energy attenuation, leading to a high rate of impulsive loading, which is known to damage cartilage cells.^{11,12} Impulsive loading has been identified in patients with ACL injury⁷ as well as patients with knee osteoarthritis,¹³ suggesting that impulsive loading may be a factor in the development of osteoarthritis following acute injury.¹⁴

Quadriceps strength predicts disease severity, disability, and quality of life in a variety of patient populations with chronic disease such as chronic obstructive pulmonary disease (COPD),^{15,16} coronary artery disease,¹⁷ and diabetes.¹⁸ Furthermore, quadriceps strength predicts mortality rates in patients with COPD.¹⁹ It is not known if diminished quadriceps strength precedes decrements in quality of life in patients with chronic disease; however, it is hypothesized that inability to effectively ambulate may increase disability related to multiple diseases.²⁰ Quadriceps strength may play a more direct role in the disability associated with chronic joint conditions. Quadriceps strength and neuromuscular activation predict disability in patients with knee osteoarthritis.²¹ Additionally, quadriceps strength predicts approximately 20% of the variance in self-reported leisure-time exercise in people with knee osteoarthritis.²² Patients that reported engaging in less frequent or less intense leisure-time exercise may have weaker quadriceps compared with knee osteoarthritis patients that report engaging in more leisure-time exercise. Maximizing strength gains during rehabilitation is important for all stages of joint injury. Establishing symmetric bilateral strength early following knee injury or in the beginning stages of osteoarthritis may benefit long-term joint health.

AUGMENTING TRADITIONAL STRENGTH TRAINING WITH DISINHIBITORY INTERVENTIONS

Traditional rehabilitation and strengthening exercises are often ineffective in individuals with knee conditions, likely due to underlying neural adaptations driving the development of muscular weakness.^{23,24} Mikesky and colleagues²⁴ reported that a 12-week strength training program improved hamstring strength but did not influence quadriceps strength in individuals with knee osteoarthritis, suggesting that neuromuscular mechanisms selectively limited the efficacy of quadriceps strengthening. Hurley and colleagues²³ reported similar results in individuals with traumatic knee injuries (eg, ACLR, meniscectomy) and observed that neuromuscular deficits influenced the efficacy of strength training because those with less neuromuscular deficit demonstrated greater quadriceps strength but those with greater neuromuscular deficit did not.

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