

# VARIABLE RESISTANCE TRAINING USING ELASTIC BANDS TO ENHANCE LOWER EXTREMITY STRENGTHENING

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## ABSTRACT

Strengthening of the quadriceps is a central tenet of lower extremity rehabilitation, particularly after knee surgery. Quadriceps deficits after various knee procedures are well-documented. One method common to strength and conditioning circles is variable resistance training (VRT). VRT involves the use of heavy chains and elastic bands to facilitate gains in strength and power. Most of the application in strength training however has been on healthy, trained athletes. Sports physical therapists may use elastic bands for VRT to augment strength gains for the recovering athlete. The purpose of this manuscript is to provide a clinical suggestion for the use of VRT in athletic rehabilitation.

**Keywords:** Eccentric training, power, strength training, variable resistance training

**Level of Evidence:** 5

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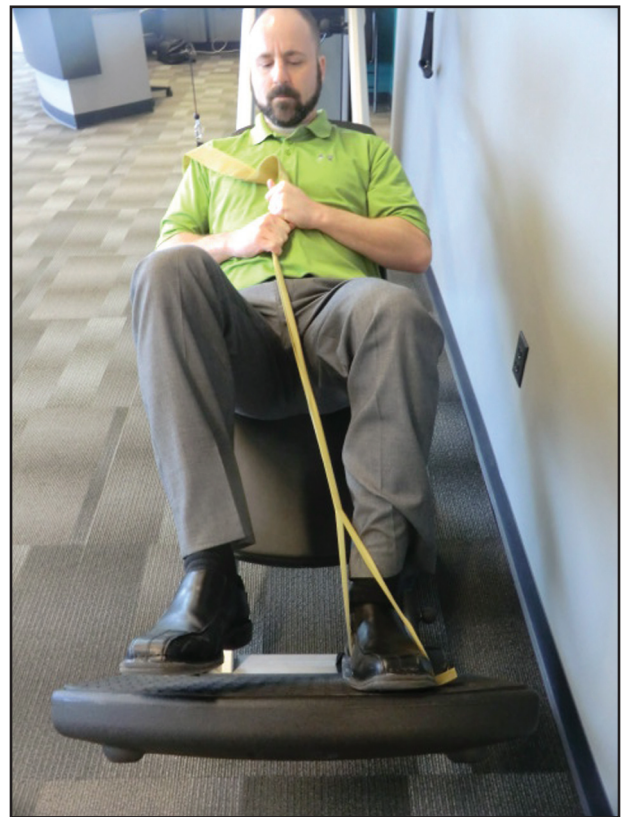
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## PROBLEM

Maximizing strength of the quadriceps is one of the main goals following knee surgery and general knee rehabilitation for the athletic population. For purposes of this manuscript, the athletic population will include not only competitive and recreational athletes but also those characterized as “weekend warriors.” Quadriceps deficits that occur following anterior cruciate ligament (ACL) reconstruction,<sup>1-4</sup> knee arthroscopies,<sup>5</sup> patellofemoral pain syndrome,<sup>6,7</sup> and total knee arthroplasty<sup>8,9</sup> are well documented. Appropriate strength is required for proper progression through a functional testing algorithm following a lower extremity injury.<sup>10</sup> There are numerous ways to strengthen the quadriceps in both open and closed kinetic chain and one method that may be used is Variable Resistance Training (VRT), which involves the use of heavy chains or elastic bands in addition to weight on a lifting bar. VRT has been used in the strength and conditioning literature in both strongman competition training<sup>11</sup> an eclectic sport where feats of strength are performed by competitors who lift rocks, refrigerators, pull trucks, and lift items overhead for example, as well as to increase strength and power in athletes.<sup>12-15</sup> However, to the author’s knowledge, it hasn’t been described as a tool to be used in sports rehabilitation. Because of the benefits in strength and power that may be realized from this method of training, it should be considered as a potential method to facilitate strength gains in the lower extremity. Potentially, it can be used earlier in the rehabilitative process as well, prior to sub-maximal or maximal strength activities instead of just in the terminal phases of rehabilitation.

## SOLUTION

The concept of VRT using elastic resistance can be used to augment an exercise like the leg press or assisted squats to enhance eccentric loading. Figures 1 and 2 show how an athlete may use bands or tubing while performing squats on the Total Gym® (Total Gym, San Diego, CA). The band should be on max tension at full extension of the hip and knee. The athlete should be instructed to lower themselves and the weight slowly and then push back to the start position. This exercise can be done with one or two legs. In Figures 3 and 4, the athlete uses bands or tubing to increase eccentric loading on the leg press machine.



**Figure 1.** Start position in full hip and knee extension with maximum tension on the band on the Total Gym® (Total Gym, San Diego, CA), single leg example. Any body weight type leg press model would work.

For athletes recovering from ACL reconstruction, this may be a particularly advantageous modification to two common exercises because of the added eccentric component to the load. Eccentric strengthening has been shown by several authors to enhance strength and cross-sectional area of the quadriceps and gluteals following ACL reconstruction.<sup>16-18</sup>

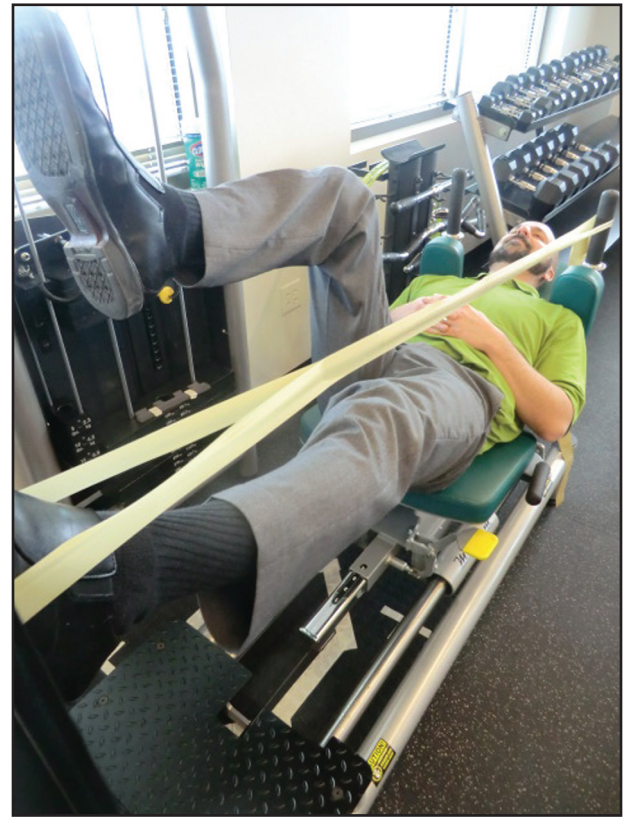
When enhancement of strength is the training objective, the athlete should perform 5-10 repetitions for 3-4 sets of the exercise. The author suggests using bands or tubing at the highest tension because lower-level resistance will not provide the overload that greater resistances provide, however, band tension should be based on the athlete’s ability to control the weight. Unfortunately, it has been shown that there is up to a 5% difference in resting tension and up to 19% in maximum tension of the same color band.<sup>19</sup> Therefore, the sports physical therapist should use discretion when not only adding VRT, but also the movement quality when the athlete or patient performs the exercise.



**Figure 2.** End of the eccentric/lowering phase using the band on the Total Gym®.

## DISCUSSION

VRT has been described in the literature as an attempt to combine the range of motion and acceleration benefits of ballistic training while allowing higher loads than are normally used in typical resistance training.<sup>15</sup> The advantage of VRT is that typical ballistic type training may be difficult to apply safely for an athlete after knee surgery. VRT allows the sports physical therapist to utilize its benefits of eccentric-emphasized training with minimal risk. In addition, VRT has been shown to be superior in increasing strength and power, as well as increasing force, lean body mass and overall EMG activity when compared to typical resistance training.<sup>15</sup> Some of these gains may be attributed to the human body having to match the loading pattern of the additional resistance, which may yield a greater overload on the muscular system. Overload is achieved by the weight on the bar plus the stretch offered by the elastic bands that serves to increase resistance. In an attempt to return to initial length the bands pull the bar downward with greater force than with free weights alone, thereby increasing the eccentric load

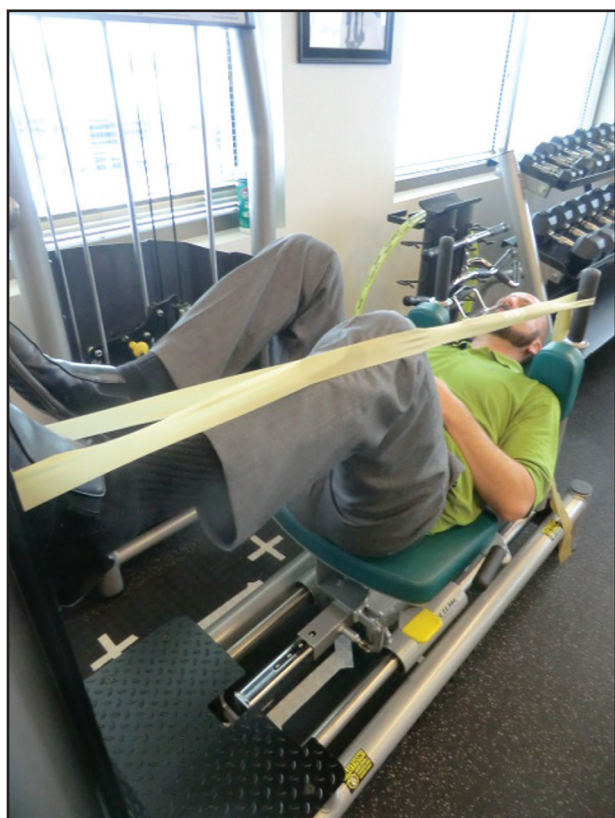


**Figure 3.** Start position in full hip and knee extension with maximum tension on the band using the Magnum Fitness leg press (Magnum Fitness Systems, Milwaukee, WI), single leg example. Any leg press model would work.

substantially when the bands are at full tension. In the same light, a concentric repetition with the elastic resistance may help athletes break their “sticking point.”<sup>20,21</sup> This strategy focuses on the top half of the repetition or the “lockout” portion since the weight exponentially increases as the bar is pushed closer to full extension, which often leads to a point where an athlete gets “stuck” and cannot lockout.

In addition, when free weights are used in conjunction with elastic bands, there may be breakthroughs of strength plateaus that are present due to neural adaptations. Shoepe and colleagues compared a group who participated with free weight training and elastic bands and a group who solely trained with free weights.<sup>22</sup> The group who trained with both the free weights and elastic bands had significantly greater strength gains as measured by 1RM in the bench press, back squat, and in lean body mass when compared to the other groups. Interestingly, Garcia-Lopez et al analyzed the amount of reps their subjects could get during a 70% 1RM bicep curl on both





**Figure 4.** End of the eccentric/lowering phase using the band on the assisted squat machine, single leg example on Shuttle.

the pulley cable, with its normal open-chain setup, and with elastic resistance attached to the cable.<sup>23</sup> The group who participated with the elastic resistance attached had a reduced maximum number of repetitions, yet a similar perception of effort. This study shows the potential efficacy of elastic resistance by bringing a muscle group to failure quicker and with equal perceived exertion as a traditional approach.

## CONCLUSION

While VRT has been used in the training of healthy athletes to maximize strength and power, it has not been studied in the recovering athlete. This clinical suggestion provides a first step in how VRT using elastic resistance might be used during the process of lower extremity rehabilitation. The concept of VRT may be extrapolated to sport rehabilitation in earlier phases of rehabilitation in order to help facilitate gains in strength and power. VRT can be particularly important for the clinician who lacks resources to train their athletes appropriately in maximizing their quadriceps strength and power. In a facility

with limited resources to maximize strength gains, VRT is a “budget friendly” method to augment strength gains without having to purchase expensive equipment or increase space to accommodate new equipment. In addition, VRT may be an alternative modality of training to help alleviate boredom or to help during times of plateau.

## REFERENCES

1. Lentz TA, Tillman SM, Indelicato PA, et al. Factors associated with function after anterior cruciate ligament reconstruction. *Sports Health*. 2009; 1(1): 47-53.
2. Moisala AS, Jarvela T, Kannus P, Jarvinen M. Muscle strength evaluations after ACL reconstruction. *Int J Sports Med*. 2007; 28(10): 868-72.
3. Tourville TW, Jarrell KM, Naud S, et al. Relationship between isokinetic strength and tibiofemoral joint space width changes after anterior cruciate ligament reconstruction. *Am J Sports Med*. 2014; 42(2): 302-11.
4. Thomas AC, Villwock M, Wojtys EM, Palmieri-Smith R. Lower extremity muscle strength after anterior cruciate ligament injury and reconstruction. *J Ath Train*. 2013; 48(5): 610-20.
5. McLeod MM, Gribble P, Pfile KR, Pietrosimone BG. Effects of partial meniscectomy on quadriceps strength: a systematic review. *J Sport Rehabil*. 2012; 21(3): 285-95.
6. Pappas E, Wong-Tom WM. Prospective predictors of patellofemoral pain syndrome: a systematic review with meta-analysis. *Sports Health*. 2012; 4(2): 115-20.
7. Pattyn E, Mahieu N, Selfe J, et al. What predicts functional outcome after treatment for patellofemoral pain? *Med Sci Sports Exerc*. 2012; 44(10): 1827-33.
8. Schache MB, McClelland JA, Webster KE. Lower limb strength following total knee arthroplasty: a systematic review. *Knee*. 2014; 21(1): 12-20.
9. Judd DL, Eckhoff DG, Stevens-Lapsley JE. Muscle strength loss in the lower limb after total knee arthroplasty. *Am J Phys Med Rehabil*. 2012; 91(3): 220-6.
10. Davies GJ, Zillmer DA. Functional progression of a patient through a rehabilitation program. *Orthopedic Physical Therapy Clinics of North America*. 2000; 9(2):103-118.
11. Winwood PW, Keogh JW, Harris NK. The strength and conditioning practices of strongman competitors. *J Strength Cond Res*. 2011; 25(11): 3118-28.
12. Burnham TR, Ruud JD, McGowan R. Bench press training program with attached chains for female volleyball and basketball athletes. *Percept Mot Skills*. 2010; 110(1): 61-8.

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13. Ghigiarelli JJ, Nagle EF, Gross FL, et al. The effects of a 7-week heavy elastic band and weight chain program on upper-body strength and upper-body power in a sample of division I-AA football players. *J Strength Cond Res.* 2009; 23(3): 756-64.
  14. Stevenson MW, Warpeha JM, Dietz CC, et al. Acute effects of elastic bands during free-weight barbell back squat exercise on velocity, power, and force production. *J Strength Cond Res.* 2010; 24(11): 2944-54.
  15. Wallace BJ, Winchester JB, McGuigan MR. Effects of elastic bands on force and power characteristics during the back squat exercise. *J Strength Cond Res.* 2006; 20(2): 268-72.
  16. Gerber JP, Marcus RL, Dibble LE, et al. Effects of early progressive eccentric exercise on muscle size and function after anterior cruciate ligament reconstruction: a 1-year follow up study of a randomized clinical trial. *Phys Ther.* 2009; 89(1): 51-9.
  17. Gerber JP, Marcus RL, Dibble LE, et al. Safety, feasibility, and efficacy of negative work exercise via eccentric muscle activity following anterior cruciate ligament reconstruction. *J Orthop Sports Phys Ther.* 2007; 37(1): 10-18.
  18. Gerber JP, Marcus RL, Dibble LE, et al. Early application of negative work via eccentric ergometry following anterior cruciate ligament reconstruction: a case report. *J Orthop Sports Phys Ther.* 2006; 36(5): 298-307.
  19. McMaster DT, Cronin J, McGuigan MR. Quantification of rubber and chain-based resistance modes. *J Strength Cond Res.* 2010; 24(8): 2056-64.
  20. Drinkwater EJ, Gaina B, McKenna MJ, et al. Validation of an optical encoder during free weight resistance movements and analysis of bench press sticking point power during fatigue. *J Strength Cond Res.* 2007; 21(2): 510-17.
  21. Krol H, Golas A, Sobota G. Complex analysis of movement in evaluation of flat bench press performance. *Acta Bioeng Biomech.* 2010; 12(2): 93-8.
  22. Shoepe TC, Ramirez DA, Rovetti RJ, et al. The Effects of 24 weeks of Resistance Training with Simultaneous Elastic and Free Weight Loading on Muscular Performance of Novice Lifters. *Am J Hum Kinet.* 2011; 29:93-106.
  23. Garcia-Lopez D, Herrero AJ, Gonzalez-Calvo G, et al. Influence of In Series Elastic Resistance on Muscular Performance During a Biceps-Curl Set on the Cable Machine. *J Strength Cond Res.* 2010; 24(9): 2449-55.