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The Truth on Fitness:
LEG EXTENSIONS

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Of the many highly scrutinized exercises used in fitness and rehabilitation settings, the one which has seemingly been subjected to the strongest opposition is the leg extension. The leg extension, involving isolated extension of the knee joint, is sometimes referred to as an open kinetic chain, or a non-terminally fixated exercise.

Opponents of the leg extension claim that the exercise imposes too much stress on the connective tissues of the knee joint, and that it induces an intolerable level of compressive loading on the patella. Concerns over joint laxity, ACL damage, and the potential onset of patellofemoral joint pain lead detractors to proclaim the leg extension off limits.

Adding support to the anti-extension movement are those who argue that leg extensions are simply not functional, given that isolated movement about the knee bears little resemblance to normal functional activities. These theorists suggest that isolated quadriceps strengthening does little to improve function, and in some cases have insinuated that such strengthening is actually detrimental to motor performance. Some have even commented that they "would never waste their time doing leg extensions."

How did such strong opinions opposing the leg extension come to exist? One source may be the seminal article from Lutz and colleagues in 1993. The authors compared anterior tibial forces (shear) during open- and closed-kinetic chain exercises, and determined that there were higher stresses imposed on the knee during open chain conditions. This article led to a series of studies in which similar findings were revealed.

The principle apprehension arising from these findings is that increased shear would impose undesirable loads on the ACL, especially during rehabilitation from ACL reconstructive surgery. By extension of this argument, detractors note that increased shear during open chain exercise would place the ACL under excessive stress in normal populations as well. The additional concerns over patellar compression lent support to this position. Thus, the exercise should be avoided by everyone.

Regarding the claims that leg extensions make no contribution to functional capabilities, or in fact, inhibit functional skill acquisition, one can only surmise that this opinion emerges as the natural outgrowth of the "functional" trend which predominates the fitness industry. For in fact, there is little to no empirical evidence that leg extensions are in any way detrimental to motor function. It is difficult to argue, for example, that the inclusion of leg extensions in an exercise regimen would negatively affect one's ability to climb stairs.

Likewise, given the critical role of the knee joint during gait, it is more likely that leg extensions would provide a substantive benefit to runners.

Consider the role of the knee during running. As the hinge between the two force-producing joints (hip and ankle), the knee serves as a critical force absorber, assisting the forward movement of the center of gravity by flexing while the stance foot transitions from heel strike to mid-stance. At eight miles per hour, for example, the rate of knee flexion at the onset of stance is nearly 800 degrees per second, slowing to 0 degrees per second in less than one-tenth of a second. The rate of deceleration of the knee from initial contact to mid-stance, therefore, exceeds 8000 deg/s. Were it not for the power of the quadriceps, and in particular the vasti, the knee would continue into flexion and the runner would collapse to the ground.

Certainly, deliberate strengthening of the Vastus Medialis and Lateralis will result in an enhanced, not impaired, ability to decelerate the knee during gait. Indeed, Newman and associates (2004) discovered a significant inverse correlation between sprint running times and knee extensor strength. In other words, the higher the knee extensor strength, the lower the sprint time.

In a study comparing open to closed chain training amongst athletes undergoing ACL reconstruction and rehabilitation, Mikkelsen et al. (2000) concluded that subjects engaging in open chain quadriceps strengthening were significantly more likely to return to their sports at pre-injury levels than those employing closed chain exercises alone.

Thus, while still prevalent in the fitness industry, the argument that open kinetic chain exercises somehow erode physical performance bears very little merit. To the contrary, it would appear that there is ample literature supporting the use of leg extensions to enhance performance.

The question still remains, however, whether leg extensions impart too much risk to the structures of the knee. As noted earlier, articles by Lutz and others indicate that open kinetic chain exercises involve higher anterior tibial forces than their closed-chain counterparts. What these studies don't relate is whether those additional shear forces are actually damaging to the knee. Herein lies an important distinction.

The fact is that shearing forces exist in all extensor movements of the knee. The very force that induces knee shear, being parallel to the joint surface of the knee, is also the principle force contributing to knee extension. Thus, without the shearing force, there will be little motive force acting at the knee joint. The question isn't whether any shear will damage the knee, but how much shear force the knee can tolerate before being subjected to strain.

Interestingly, a thorough search of the scientific literature reveals meager evidence suggesting that leg extensions introduce dangerously high shear stresses. Moreover, there are few, if any, documented cases of healthy subjects tearing their anterior cruciate ligaments on leg extension machines.

On the other hand, there is ample evidence suggesting that open kinetic chain exercises are no more stressful than terminally fixated exercises, and that the inclusion of leg extension exercise results in greater rehabilitative benefits to the very ACL patients about whom the initial concerns arose.

Studies by Perry and colleagues (2005) and Tagesson et al. (2007), for instance, indicate no differences in anterior joint laxity in ACL patients after several weeks of either open or closed kinetic chain rehabilitation. Tagesson's results also indicate that subjects in the open chain group demonstrated significantly greater quadriceps strength than those in the closed chain group. It is particularly noteworthy that these subjects were ACL deficient, and therefore, more highly susceptible to shearing stress. Yet, no strains were reported.

Concerning excessive patellar compressive forces, Cohen and associates (2001) as well as Morrissey et al (2002) report no differences in compressive loading or patellar pain between open or closed chain conditions, leading these authors, as well as others to conclude that leg extensions were not detrimental to knee patients. Fleming et al (2005), in an extensive review of the literature, suggested that open kinetic chain exercise should be an essential component of ACL rehabilitation. Thus, one could extend these findings to suggest that leg extensions pose no risk to healthy individuals either, and are therefore beneficial to the stable knee group.

Opinions abound in the fitness industry, and it is often opinion that takes precedence over scientific evidence. The truth is, that supported by ample empirical scientific evidence, leg extensions, used intelligently, should be considered an important component of all lower body strengthening regimens.

References

Cohen, Z.A., Roglic, H., Grelsamer, R.P., Henry, J.H., Levine, W.N., Mow, V.C., and Ateshian, G.A. (2001). Patellofemoral stresses during open and closed kinetic chain exercises. *Am. J. Spts. Med.* 29(4): 480.

Fleming, B.C., Oksendahl, H., and Beynnon, B.D. (2005). Open-or closed-kinetic chain exercises after anterior cruciate ligament reconstruction? *Exerc. Sport Sci. Rev.* 33(3): 134-140.

Lutz, G.S., Palmitier, R.A., An, K.N., and Chao, Y.S. (1993) Comparison of tibiofemoral joint forces during open kinetic chain and closed kinetic chain exercises. *J. Bone Joint Surg.* 75: 732-739.

Mikkelsen, C., Werner, S., and Eriksson, E. (2000). Closed kinetic chain alone compared to combined open and closed kinetic chain exercises for quadriceps strengthening after anterior cruciate ligament reconstruction with respect to return to sports: a prospective matched follow-up study. *Knee Surg Sports Traumatol Arthrosc.* 8(6): 337-342.

Morrissey, M.C., Drechsler, W.I., Morrissey, D., Knight, P.R., Armstrong, P.W., and McAuliffe, T.B. (2002). Effects of distally fixated versus nondistally fixated leg extensor resistance training on knee pain in the early period after anterior cruciate ligament reconstruction. *Phys. Ther.* 82(1): 35-43.

Newman, M.A., Tarpenning, K.M., and Marino, F.E. (2004). Relationships between isokinetic knee strength, single-sprint performance, and repeated-sprint ability in football players. *J. Strength Cond. Res.* 18(4): 867-872.

Perry, M.C., Morrissey, M.C., Knight, P.R., McAuliffe, T.B., and King, J.B. (2005). Knee extensors kinetic chain training in anterior cruciate ligament deficiency. *Knee Surg Sports Traumatol Arthrosc.* 13(8): 638-648.

Tagesson, S., Oberg, B., Good, L., and Kvist, J. (2007). A comprehensive rehabilitation program with quadriceps strengthening in closed versus open kinetic chain exercise in patients with anterior cruciate ligament deficiency: a randomized clinical trial evaluating dynamic tibial translation and muscle function. *Am J Spts Med.* 36(2): 298-307.

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