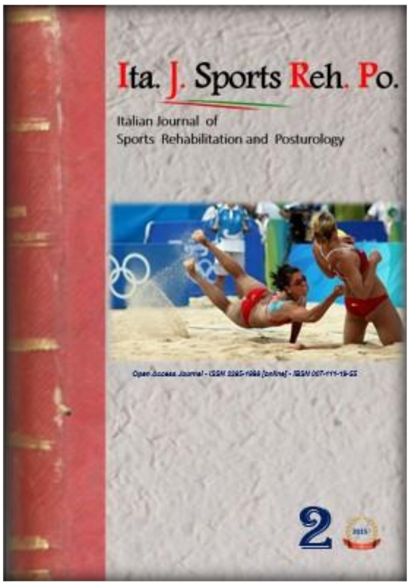
Ita. J. Sports Reh. Po.

Italian Journal of
Sports Rehabilitation and Posturology

Open Access Journal - ISSN 2385-1988 [online] - IBSN 007-111-19-55

2



Editor in Chief : *Rosario D'Onofrio*
Current issue : *April 2015*
Volume : 2
Issue : *2*
Page : 211 - 258
Years : *2*
Publication Start Year : *2014*
Country of Publication: *Italy*
Title Abbreviation: *Ita J Sports Reh Po*
Language : *Italian/ English*
Publication Type(s) : *No Periodical*
Access Journal : Free (Only Members)
ISSN : *2385-1988 [Online]*
IBSN : *007-111-19-55*
ISI Impact Factor : *None*
Index : *Open Academic Journals Index (OAJI)*

Italian Journal of Sports Rehabilitation and Posturology ɔurnal of Sports Rehabilitation and Posturology

Ita. J. Sports Reh. Po.

Italian Journal of
Sports Rehabilitation and Posturology

Official Journal of the :

- Italian Scientific Society of Rehabilitation and Posturology of the Sports
- Italian Football Medical Association
- Italian kinesiological Taping Association
- Italian Group for Evidence Based Sport Osteopathy
- European Academy of Osteopathic Medicine

Italian Journal of Sports Rehabilitation and Posturology ɔurnal of Sports Rehabilitation and Posturology

Ita. J. Sports Reh. Po.

Italian Journal of
Sports Rehabilitation and Posturology

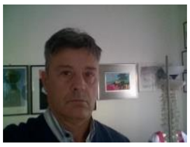
Italian Journal of Sports Rehabilitation and Posturology

Dear Readers,

The idea of creating an Italian Journal of Rehabilitation and Sport Posturology in English, with an international outlook, will allow us to establish a scientific exchange with health professionals who deal with sport all over the world.

This is a very interesting aspect of our study. It will enable us to widen the sphere of our professional experiences, both the theoretical and the practical ones, and to enter into relations with different scientific circles. The written and the oral exchange of information is the source and the essence of knowledge and it allows us to have an ethical, serious, professional communication whose content is validated by the International Scientific Literature.

Our editorial purpose in Italy is to encourage studies and researches, not only in Universities, but also in sports in order to avoid the empiricism that for years has understimated the Rehabilitative Science applied to Sport.

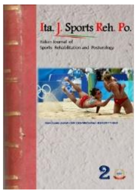


Rosario D'Onofrio
Editor In Chief

Table of Contents

Ita J. Sports Reh. Po. 2015 ; Vol. 2 ; 2; 211 -259

Articles



Massimo Armeni
Leg Extension Exercise : from Clinical Biomechanics to Neuropostural Patterns
A Critical Review
Ita J Sports Reh Po 2015 ; 2; 2 ; 224 -231
ISSN 2385-1988 [online] - IBSN 007-111-19-55

Ita. J. Sports Reh. Po.

Italian Journal of
Sports Rehabilitation and Posturology

Leg- Extension Exercise : from Clinical Biomechanics to Neuropostural Patterns . A Critical Review

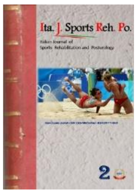
Massimo Armeni

[1] *International Sports Sciences Association of Europe,*
[2] *American College of Sports Medicine,*
[3] *Accademia Italiana Terapia Osteopatico Posturale,*
[4] *Head of Research, Istituto per le Terapie Craniosacrali, Norma, Italia*

Learning objectives

Observation of the safety of the exercise, discussing the neurophysiology, functional anatomy, the isokinetic system, the correct posture to assume while using the utensil and possible risks to the knee compartment.

Key words: Leg-Extension, Biomechanics, Posture, Isokinetic



Massimo Armeni
Leg Extension Exercise : from Clinical Biomechanics to Neuropostural Patterns
A Critical Review
Ita J Sports Reh Po 2015 ; 2; 2 ; 224 -231
ISSN 2385-1988 [online] - IBSN 007-111-19-55

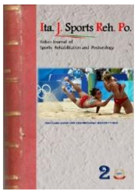
Abstract

The leg-extension exercise is a universally recognized exercise, proposed for the analytical strengthening of the quadriceps muscle (Fig.1). Its applicability especially in rehabilitation and in the fitness field, today, is being much questioned by literature, particularly by those concerning rehabilitation of knee pathologies. This current orientation finds ample evidence in relation to the important patello-femoral joint compressive forces that the knee extension can create[9]. Despite the leg extension machine being invented to solicit selectively the thigh musculature without placing excessive loads on the spine, and potentially, the risk of injury increases as the knee and lower leg do not work correctly. Furthermore, in soliciting the lower extremities by sitting at an angle of 90°-120° between the pelvis and the spine, the latter is maintained verticalized at the lumbar region and this inversion of curves is not free from risks in hypomobile subjects_or suffering from spinal pathologies. The object of this study is to analyze the validity of the exercise in an open kinetic chain defined as “leg-extension”.

Fig.1

Neurophysiological Considerations

From a neurophysiologic point of view, the more advanced research can help us understand a little better the human dynamics and mechanics applied to the exercise in question.



Ita J Sports Reh Po 2015 ; 2; 2 ; 224 -231
ISSN 2385-1988 [online] - IBSN 007-111-19-55

Physiologically the neurological afferent impulse – therefore: the “return” – originates from the sole of the foot (forefoot, hind foot, ect.), involving mechanically the intrinsic/extrinsic muscles of the foot, the sub-talar and tibio-tarsal mortise, the distal tibio-fibular joint, the femur, the proximal tibio-fibular joint, the patella (ie ligaments, muscles, bursae, cartilage, endo/exo receptors ect.) through nerves and muscles. In this context, the hind foot is the are of support and the fore foot is the sensitive area: for a better understanding let us compare them with spinal metamerism, in which the styloid of the 5° metatarsal and the 1st cuneiform represent the neuro-physio-postural reflexes of neuro-ascendent receptor activation. The foot represents the fixed point of postural sway, but it is also modulator and a pivot in the role of reference exo and proprioceptive in the continuous changes and muscular tone adaptations, mainly through the Pacinian corpuscles, deep mechanoreceptors. We can also affirm with certainty, that the plantar support will also affect the intrinsic muscle of the spine starting from the 3rd lumbar vertebra. The articular receptor involvement, of muscle spindles and Golgi tendinous organs located in the antigravity extensor muscles of the lower leg exerts the greatest afferent stimulus effect in the cerebellum. So to summarize, there is a neurophysiological receptor activation circuit that coordinates and protects our biodynamic from the moment our foot touches ground. In the light of all this, it remains a mystery why they choose to train the quadriceps by lifting the foot off the ground as in the case of leg-extension, especially if the above circuit is activated only by “closing” a arthrokinematic chain (feet on ground).

Functional Anatomical Considerations

Also from the essentially biomechanical point of view, besides, the exercise in an open chain and with feet “released” from the ground is not functional: as it cancels the simultaneous involvement of the hip and knee joint in the lower extremity extension action, which takes into account the physiological nature of the bioarticular rectus femoris and that determines a synergic controlling and fixating contraction of the posterior thigh muscles (ischiotibials), like on the leg-press or squat, or the simple act of walking, running; the bio-articular peculiarities of the rectus femoris is not respected, rather it is contradicted by the sitting position with hip flexion, able to perform an extension movement instead. In addition, the lack of foot support to the ground forces the quadriceps to work free from gravity, when in fact the entire structure of the lower limbs is conceived as a complex system of levers capable of counteracting the resistance impressed by gravity, and therefore, once again, the articular physiology is not respected. A detailed analysis of the biomechanics applied to the exercise in question, shows that the knee is being abnormally utilized. The knee joint is a trochoid sliding (pivotal hinge joint), therefore its mechanism suggests a semi-rotating movement combined with a sliding one. It is mainly an articulation at a single degree of freedom, that works essentially in compression, under the effect of gravity. This explains the presence of the ligament and adipose plicas, which provide cushioning from the stress placed on the joint. In flexion it can perform movement in rotation, which ensures a second degree of freedom to this complex joint. The structure that functionally prevents the movement of anterior translation of the tibia on the femur is the anterior external cruciate ligament (ACL) (Fig.2)

Massimo Armeni
Leg Extension Exercise : from Clinical Biomechanics to Neuropostural Patterns
A Critical Review
Ita J Sports Reh Po 2015 ; 2; 2 ; 224 -231
ISSN 2385-1988 [online] - IBSN 007-111-19-55

Fig.2

it anatomically runs obliquely superiorly laterally, and absorbs about 86% of the global mechanical stress, or rather, of "*the anterior drawer"*, while the posterior cruciate ligament (PCL) provides instead 95% of the total force limiting the "*posterior drawer*" or posterior traslation of the tibia[2]. During flexion movement, an internal rotation of the tibia is determined and the passage from the combined rolling/gliding is produced and controlled by the ACL that wraps around the PCL. This way the knee has the least anatomical freedom, in other words it is at its maximum stability. In carrying out the opposite movement, the one of extension, the cruciates relax, becoming vertical, and cause the tibia/ femur rapport to be less stable. In association with the extension movement there is an external rotation of the tibia, while the PCL allows a correct biomechanical execution of the movement. Both ligaments contribute to the antero-posterior mechanical stability of the knee, avoiding abnormal translations of the tibia on the femur. The ACL opposes itself to solicitations that determine excessive anterior forces, produced by the intensity of the muscle activity and the working angle. The anterior cruciate ligament reaches its maximum tension in internal rotation and flexion at an angle of approximate of 15/20°. According to these biomechanical observations applied to the exercise in question, knee extension from a seated position against resistance (the machine roller on the tibia), creates a significant component of cutting force, or extra-axial, in the joint, absolutely non physiological, therefore large compressive forces are generated at the patella-femoral joint, (Fig.3)

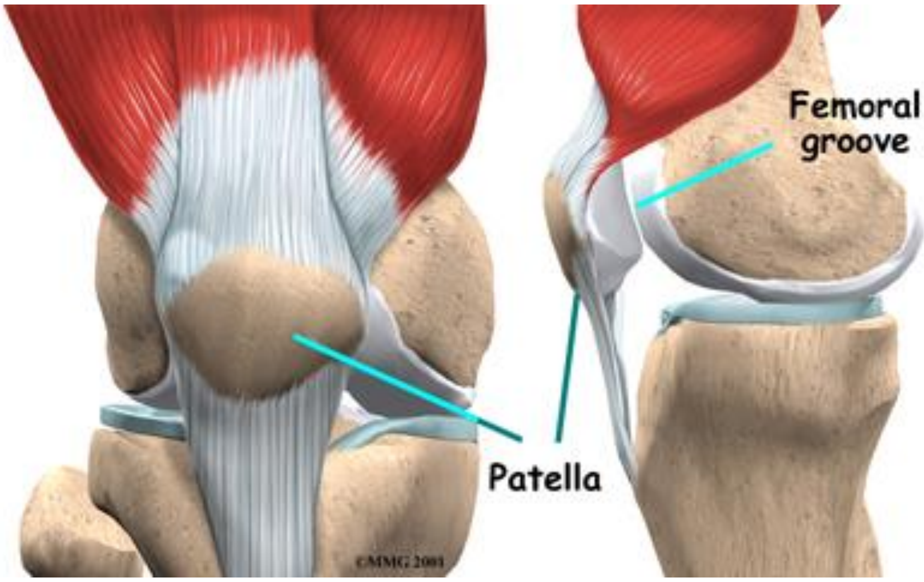


Fig.3

although these forces diminish in a directly proportional manner to the more distal application of the load ("removal" of the tibia-tarsal joint and "approach" to the tibial plateau). Additionally, the ACL is stretched in extension and represents one of the brakes for hyperextension – movement that occurs in the leg-extension -, therefore it will be more stressed by this exercise. The activity of the hamstrings muscles assist to ACL ligament protection and tibiofemoral joint stability in leg-extension exercise[1] and also limits anterior translation of the tibia on the femur[6], except at a range between 180°-165°, thus making the knee more vulnerable.In reference to specific working angles certain diversified forms of overstress are created. These forces are broadly summarized as follows:

a) Patello-femoral joint compressive forces

b) Anterior Shear Forces, or tibial femoral shear forces.

The isolated contraction of the quadriceps is the vector that creates, in both cases, forces that are most damaging for the knee joint, especially in the last degree of extension (30°-0°) as extensive literature evidence on the subject has emphasized[4,5].

Isokinetic regime

The considerations set out above refer to the exercise in an isotonic regime, but not in isokinetic regime. In this regime, the high forces arise in the ACL when the knees extended more than 60 degrees[10]. In an interesting study of 12 weeks on young jumping athletes[3] the

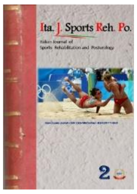
authors compared the validity of the exercise conducted in an isokinetic regime in leg extension and leg-curls with the Cybex II at 30°/s, with exercises of drop squat (DS) in a closed kinetic chain under isotonic/explosive regime; both modalities of exercise were considered valid in the reduction of pain and in the accelerated return to athletic activities.
The extension isokinetic exercise in an open kinetic chain, if carried out at a high velocity, seems to guarantee and improve the co-activation of the hamstring compared to the exercise carried out in a closed kinetic chain[8] but only at certain angles; in fact from a study[7] conducted on knee flexors and extensors in male and females, its proved that the angle at which the peak of torsion is reached is greater than 180°/s - 240°/s that at 60°/s, except on knee flexors of woman tested at 60°/s.
On the contrary, re-examining the exercise carried out in a isotonic mode, in many experts opinion, that the exercise in a closed kinetic chain in extension should be avoided, or performed with a reduced Range Of Motion (ROM) and low resistance forces in the presence of a cruciate ligament injury (Fig.4) or a reconstruction of the lateral and collateral ones.

Fig.4

Correct posture to assume when using the leg-extension machine

That said, if the leg extension exercise were proposed, it is necessary to maintain some technical precautions to prevent damage to bones, joints and myofascial, which are exsposed as follows:

- The position to assume and mantain during the exercise on the machine is with the subject seated with knees higher than the hips



- The angle that forms between the backrest and the seat must be greater than 90° for this to be in accordance with the physiological angle between sacrum and femur; in fact the correct tone of the isciotibials muscles allow the hips to flex with the legs extended at no more than 110°; a greater or minor flexibility are to be considered non-functional for the chain.

- Flex the knees at an angle 90°, no further even if the machine allows it to avoid stress to the knee compartment especially the PCL

- Feet should point towards the ground, or at least kept in a natural position, without forcing dorsiflexion of the ankle.

- Control the extension ROM and setting of the backrest: if the lumbar spine assumes a kyphotic attitude prevent a complete extension of the legs as to avoid compromising the lumbar lordosis.

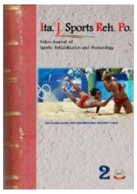
- At the end of the extension stroke always maintain a 5-10° flexion of the knee with the toes always facing down and forward and slightly rotated externally, all that respect the natural anatomical relationship between the tibia and femur, prevents possible injuries especially of the ACL, and it does not exert an excessive eccentric contraction of the posterior muscular chain.

Conclusions

In the light of the current literature and in relation to the anatomical knowledge of the knee, the leg extension exercise, eg in the field of fitness and especially rehabilitative, remains controversial. Its use in muscle strengthening training requires care and attention to detail, and it cannot be separated from the functional assessment carried out pre-training and from a clinical status knowledge relative to the knee joint area. Therefore exercises performed in closed kinetic chain that promotes more balanced quadriceps activation - eg on the horizontal leg-press or on free squatting - than does exercise in open kinetic chain[11], in this opinion, represent a muscular work that respects the neurophysiology and human biomechanics.

Condensed Version & Bottom Line

The leg-extension exercise is a recognized exercise proposed for the analytical strengthening of the quadriceps muscle in open kinetic chain, but its use in fitness and rehabilitative fields remains controversial. If this exercise were proposed, it is necessary to maintain some postural precautions to prevent damage. Therefore exercise physiologists and athletic trainers can to advise at theirs clients a mixed exercise prescription, such as the leg-extension exercise and the exercises performed in closed kinetic chain, such as squat or/and leg-press.



Massimo Armeni
Leg Extension Exercise : from Clinical Biomechanics to Neuropostural Patterns
A Critical Review
Ita J Sports Reh Po 2015 ; 2; 2 ; 224 -231
ISSN 2385-1988 [online] - IBSN 007-111-19-55

References

1. Biscarini A, Botti FM, Pettorossi VE. Selective contribution of each hamstring muscle to anterior cruciate ligament protection and tibiofemoral joint stability in leg-extension exercise:a simulation study. *Eur J Appl Physiol.* 2013;113:2263-73

2. Butter DL, Noyes FR. Ligamentous restraints to anterio-posterior drawer in the human knee. A biomechanical study. *J Bone Joint Surg Am.* 1980;62:259-70.

3. Cannell LJ, Taunton JE, Clement DB, Smith, Khan KM. A randomised clinical trial of the efficacy of drop squats or leg extension/leg curl exercises to treat clinically diagnosed jumper's knee in athletes: pilot study. *Br J Sports Med.* 2001;35:60-64.

4. Escamilla RF, Zheng N. Biomechanics of the knee during closed kinetic chain and open kinetic chain exercises. *Med Sci Sports Exerc.* 1998;30:556-69.

5. Frontera WR, Hughes VA, Dallal GE, Evans WJ. Reliability of isokinetic muscle strength testing in 45- to 78-year-old men and women. *Arch Phys Med Rehabil.* 1993;74:1181-5

6. Henning CE, Lynch MA, Glick KR Jr. An in vivo strain gage study of elongation of anterior cruciate ligament. *Am J Sports Med.* 1985;13:22-26.

7. McCaw ST, Melrose DR. Stance width and bar load effects on leg muscle activity during the parallel squat. *Med Sci Sports Exerc.* 1999;31:428-36.

8. Miller JP, Croce RV. Analyses of isokinetic and closed chain movements for hamstring reciprocal coactivation. *J Sport Rehabil.* 2007;16:319-25.

9. Nisell R, Ekholm J. Patellar Forces During Knee Extension. *Scand J Rehabil Med.* 1985;17:63-74.

10. Nisell R, Ericson MO, Németh G, Ekholm J. Tibiofemoral Joint forces during isokinetic knee extension. *Am J Sports Med.* 1989;17:49-54

11. Stensdotter AK, Hodges PW, Mellor R, Sundelin G, Häger-Ross C. Quadriceps activation in closed and in open kinetic chain exercise. *Med Sci Sports Exerc.* 2003;35:2043-7.

Ita. J. Sports Reh. Po.

Italian Journal of
Sports Rehabilitation and Posturology

OAJI .net Open Academic Journals Index

Italian Journal of Sports Rehabilitation and Posturology
ISSN 2385 -1988 [online]

IBSN 007-111-19-55

Italian Journal of Sports Rehabilitation and Posturology ISSN 2385-1988 [online] - IBSN 007-111-19-55
Società Scientifica Italiana di Riabilitazione e Posturologia dello Sport C.F. 90060850592
Info mail : info@italianjournalsportsrehabilitation.com - http://www.italianjournalsportsrehabilitation.com/