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The SLR test – neurodynamics and biomechanics

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Summary

The SLR test (straight leg raise), often reffered to as Lasègue's test, is one of the most often used provocative manoeuvres among patients with the pain ailments of the lower back (LBP). For the first time it was described in 1880 by a Serbian doctor called Lazerevic and since then numerous versions od this test has developed (1).

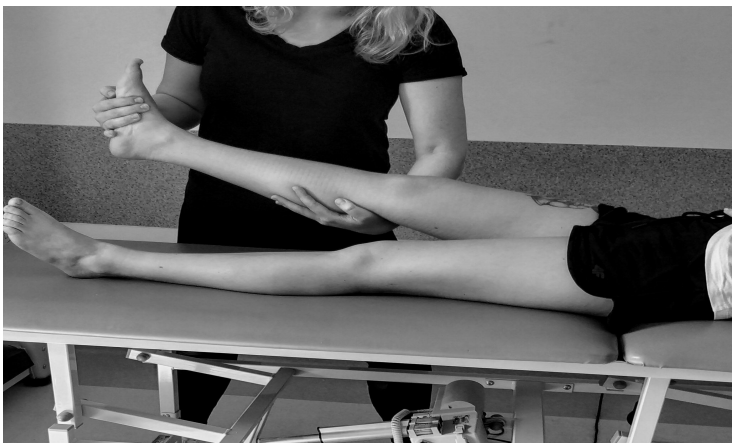
According to the authors' own experience, despite its large popularity in the clinical practice, the practitioners' interpretation of the test is often incorrect and is entirely confined to indicating the results in the dichotomous scale with the determination of the pain level. Such interpretation of the test cannot indicate the source of the pain ailments reported by the

patients, all the more become a reference point for the treatment strategy. This study focues on the basic rules of neurodynamics and biomechanics of the SLR test and its varieties- the dynamic test of tibal, peroneal and sural nerves, which should serve as a model for working with the LBP patients.

Key words: SLR test

The SLR test

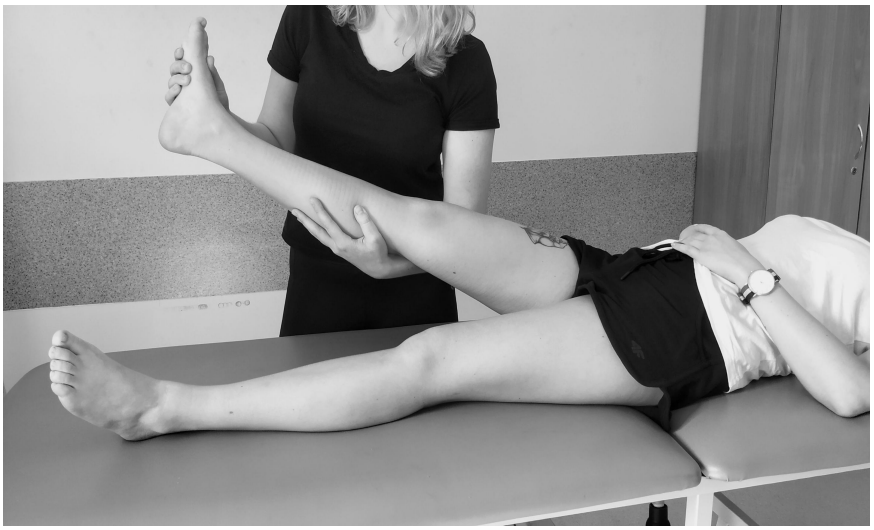
Conventionally described by JJ Frost, the SLR test is performed in the lie back position by passive lifting of a leg with a knee streghtened out till the moment when the pain in the low back occurs and it radiates along the lower limbs, next the therapist repeats the movement with the leg bended in the knee and the hip (3). If the differentiating movement occurs simultaneously with the change of symptoms, the involvement of the neurodynamic movement is possible. It is essential to avoid various deviations while performing movements in the frontal and transverse planes because those movements increase the test sensitivity (further discussion on this topic will be presented in another part of this article). This manoeuvre is used when the pain ailments and other sypmtoms occur in the posterior and the lateral sides of the lower area of the body, however it can also be applied in the pain ailments of the thoracic spine (4).



Dwg. 1. The SLR test.

The TNT test.

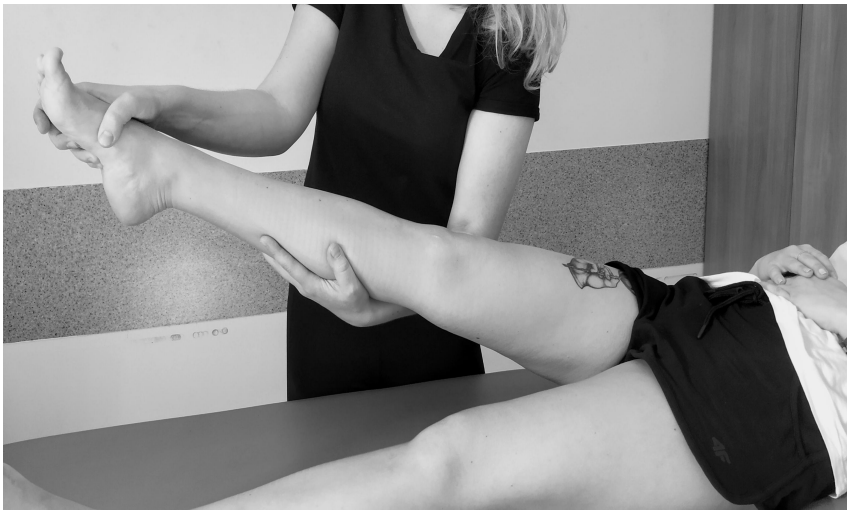
The TNT test *(tibial neurodynamic test)* is a classical variation of the SLR test, where diagnostics is aimed at the tibal nerve. Additional dorsal flexure and bending of a feet are the main difference, this movement is performed as a first one during the test. This manoeuvre cause the direct tension of the nerve. This test is advisable in case of pain ailments of calf, heel or plantar foot area (5).



Dwg. 2. The TNT test.

The PNT test.

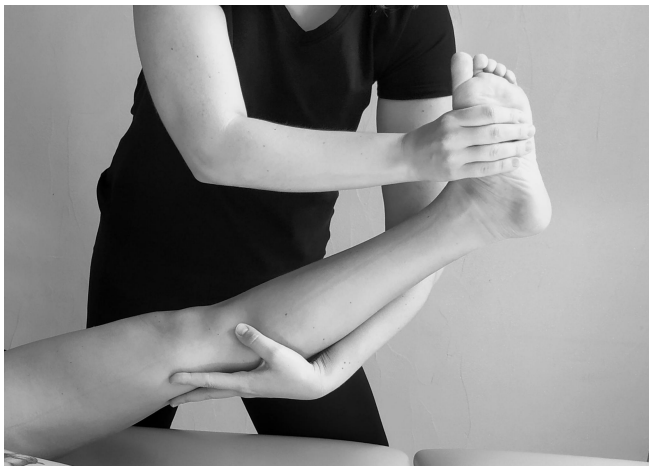
The PNT test (*peroneal neurodynamic test)* is used to examine mechanical and sensory functions of the peroneal part of the sciatic nerve. It focues the most on the common peroneal nerve and the superficial peroneal nerve. This manoeuvre is advisable in particular condition which causes the ailments in the area of anterior and lateral compartment of the leg and dorasal foot, and in case of a radicular pain L4-L5. The PNT test differs from the above mentioned tests in plantar flexure, inversion and bending of the toes. Those movements are performed before lifting a leg with a knee streghtened out (6).



Dwg. 3. The PNT test.

The SNT test.

The SNT test (*surae neurodynamic test*) is used when the pain occurs in a posterolateral calf, an ankle joint or a foot. In practice it is performed in case of a sprained ankle joint, a radiculopathy S1, a cubic bone syndrome, peroneal muscles inflammation. The SNT test differs from the above mentioned tests in dorsal flexure and foot inversion. Those movements are performed as first ones during the test (7).



Dwg. 4. The SNT test.

The SLR test average test sensitivity is 0,84 (0,72-0,92) and average test specificity is 0,78 (0,67-0,87) (8). It was also observed that the traditional SLR test which is performed in a lie back position is more sensitive than the SLR test performed in a sitting position among patients with lumbar radiculopathy symptoms, whose the Magnetic Resonance examination confirmed compression on the sciatic nerve (9). However, it is still disputable whether those tests can detect a heriniated disc, and thereafter nerve root compression or hypersensitivity of spinal nerves and a femur caused by mechanical irritation (9).

Position of the nerves.

The sciatic nerve (*nervus ischiadicus*), formed by nerve branches L4-S2, is a final branch of the sacral plexus. The course of the nerve starts in the pelvis and from there ,through a greater sciatic foramen, goes between a greater trochanter and a ischial tuberosity, then through a posterior surface of an aductor magnus under a biceps fermoris, a semimembranosus and a semitendinosus, where it is divided into a tibal nerve and a peroneal nerve (10).

The main branch of sciatic nerve is the tibal nerve (*n. tibialis*), it streches out through posterior surface of a crus, it wreaths a medial malleolus tunnel and further to a plantar foot area, where it is divided into two final branches: a medial plantar nerve and a lateral plantar nerve. The medial plantar nerve goes to an abductor hallucis and a flexor digitorum brevis, the lateral plantar nerve supplies an abductor digiti minimi and a quadratus plantae (10).

The common peroneal nerve *(n. peroneus communis*) which is a second branch of the sciatic nerve divides into a superficial peroneal nerve and a deep peroneal nerve. The motor part of the superficial peroneal nerve goes to a peroneus longus and a peroneus brevis, its sensory part reaches to toes, except the lateral surface of the fifth toe (11).

The sural nerve (*n. suralis)* is not a direct branch of the sciatic nerve, it starts at the connection of the lateral sural cutaneous nerve, which is a branching of the common peroneal nerve and the medial cutaneous nerve of a calf, which belongs to the branch of the tibal nerve. It wretches the lateral malleolous and streches out to the lateral dorsal cutaneous nerve, which goes to the posterolateral skin surface of the heel and to the lateral ridge of a feet (10).

Neurodynamics

In a neurological mechanism, which generates the pain ailments, the dorsal root ganglion, the nerve roots and the peripheral nerves build the peripheral neurogenic mechanism. Notably, a connective tissue of the nerve system is responsible for the noiciceptive mechanisms, because it also belongs to innervated tissues (12).

Generating a movement in the nervous system is possible thanks to three basic mechanical functions: resistance to tension, ability of a gliding movement relative to surrounding tissues and compression strength (12).

The most important places, which causes the increase of nerve tension in the SLR test are: a hip joint, a knee joint and an ankle joint. Respectively: bending, extension and dorsal or plantar flexure (depending on the examined nerve TNT, PNT) will cause the increase of strength acting on the nerve. Some kind of a guard, which protects the nerves from excessive tension or breaking, is the perineurium. It is build from a thickly located connective tissue, which takes part in building each nerve fibre and it is characterised by significant resistance to elongatinon, due to owned flexibility. Thanks to it, peripheral nerves can resist streching that reaches 18-22 % before they may be damaged. The sciatic nerve in the SLR test can elongate its length by 124 mm. Therefore, when there is a person measuring 1,75m the nerve can extend by 14% (13).

It was demonstrated that the time from extension of a nerve by 12% till the moment when changes in the nerve conduction occur equals a few seconds. In case of a person who suffers from the neuropathy such changes are observed only after a minute. (14).

During a classical SLR test in the range between 0° and 35° there is a release of tension in the sciatic nerve and marginal movement of nerve structures. However, the fastest movement of the nerve roots occurs in the range between 35° and 70° and it stops between 70° and 90°. Therefore, starting from about 60° a fast increase of a nerve tension happens. Due to this fact, the sliding movement therapy of the sciatic nerve requires an apllication of movement of a large amplitude in the middle range of movement, while the stretching therapy should be performed in the final range of this movement (15).

Another factor of neurodynamics is the phenomenon of convergence connected with the nerve compression. It consist in performing a sliding movement toward the joint or other limiting structure and it mostly happens in its external area. To ilustrate, for instance during the TNT test beside a sliding movement of the tibal nerve under the tendinous arch of soleus compression happens in a canal of the medial malleolus between the external and the internal lamellae of the flexor retinaculum (15).

The ability to absorb forces perpendicular to a nerve is provided by the epineurium. It gives the nerves the properties of a sponge, therefore, after the cessation of pressure, the crosswise dimension returns to its original size (16). However, after exceeding the pressure force of 30-50 mmHb blood flow disorders, hypoxia and abnormalities in conductivity and axonal transport may occur, consequently, it leads to the damage of the nerve (17).

A significant role in generating nociceptive impulses plays the blood flow inside the nerves. Only changes of its circulation, despite the lack of differences in speed of conduction, may be the cause of pain ailments. If the nociceptors are triggered, not only the pain is initiated, but also a local change of blood flow occurs. This process happens thanks to Substance P and a peptide dependent on a gen coding calcitonin (CGRP) released by nerve fibre endings to blood vessel walls located in the inside of the nerves (18). The nociceptors C are activated by capsaicine and are located in the epineurium. The stimulation of the nociceptors results in the increase of blood flow in the nerves in the place of their initiation. When it is excessive it may lead to inflammation and/or swelling, which then cause the formation of a mechanism of a vicious circle. The inflammation may secondarily cause compression or streching the nerve structures. It is known that extension of the nerve by 8 % results in the reduction of the venous circulation, when it is extended by 15 % both the venous and the arterial circulation are blocked. On the other hand, kepping the nerves tensed by 60% during only 1 hour reduces conductivity by 70%. In a situation when this time is prolonged, time of the covalescenece is increased (19).

What also influences the progress of the test are strength and range of the movements in joints. When the nerve system is relaxed, small forces will mostly cause local effects. In the phase of high tension, this tension will be used to indicate the movement in the nerve tissue. Located in a large distance from the point of force application, as in the SLUMP test (20).

Biomechanics

On the plane of the neurodynamics of the nerve system overlaps the biomechanical aspect of the musculo-sceletal system. Therefore, there is a need to realise that it is impossible to unambigiously and indisputably determine the source of the observed ailments in the SLR test. In this regard any clinical hypotheses made, will be the resultant of the test and additional differentiating factors considering the bio-psycho-social aspects (20).

For instance, the occurrence of the pain ailments in the SLR test in the lower limbs area with the flexion of 10° and higher, does not have to be caused by disorders of the nerve system. It was observed, that above of this angle, in the hip joint the retroversion of the pelvis occurs caused by ischiofemoral muscles, which may be the source of the pain. It is also known that the flexion in the hip joint is responsible for 44% of changes in the length of the sciactic nerve in the SLR test, whereas, the extension in the knee joint elongates its length by

60mm, contributing to the elongation of the nerve by 49% (21). What is more, the internal rotation and the adduction increase the test sensitivity by additional tension of the nerve structures located at the back of the joints.

The increase of the test sensitivity happens also in the distal part of the examined limb. The dorsal flexion and the eversion of the feet increases the tension of the posterior tibal nerve. It results in the increase of compresion of the mentioned nerve by 32 mmHg, exceeding from 7 to 16 times the pressure on the nerve in its neutral position (19). The inversion of a feet may have a great significance in diagnostics of the piriformis muscle syndorme, as the described manoeuvre irritates the sagittal part of the sciatic nerve, up to a height of the pelvis, however, only among patients with the division of the sciatic nerve on the tibal and the peroneal part located high (22).

It was experimentaly proved that in time of the full range of the spine movement, from the full flexion to the extension in the lumbar area, the tension within the dura mater can increase by 30%, within the nerve roots by 16% and within the sacral spine by 10-20% (23).

From the clinical point of view it need to be realised that flexion of the spine increases the tension of nerve structures and at the same time decreses the pressure put on them. Therefore, the ailments of LS part of the spine, resulting from the tension of the nerve roots, can be induced by the SLR test and the spine flexion (23). However, the ailments connected with the pressure on the nerve structure within the vertebral canal or the intervertebral foramina occur typically during the extension. That is for instance why patients diagnosed with LS stenosis feel better while walking upwards as the spine is in the conjugated position (24).

During the SLR test small tension within the nerve structure from the craniospinal side occur, which enables bigger than in the SLUMP test displacement of the nerve roots in the caudal direction. If the examined feels growth of ailments in the first mentioned test, it means that the disorder concerns the lack or the increase of sensitivity on the gliding motility of the spinal cord in the caudal direction, not the incresed tension of the nerve structures (25).

The analysis of 10 most important basic life support systems of human body — cardiovascular (CVS), respiratory (RS), nervous (NS), digestive (DS), endocrine (ES), immune (IS), excretory (EXS), brain (BS), musculo-skeletal (MSS), hematopoietic (HS) was

carried out. Based on this analysis two levels of ensuring the reliability of organism's work were revealed: sequential and parallel.

The system of logical equations for reduced sequential system is: Ys1 = CVS RS BS, where is the notation for the conjunctions of set elements.

The system of logical equations for the reduced parallel system is: Ys2 = NS DS ES IS HS EXS MSS, where is the disjunction of the scheme elements.

Visualization of human STC changes the concept of the kinetics of age-related changes in the organism and the role of determinants of health as a stable factor accompanying a uniform, smooth transition from the most pronounced functions of the body to their gradual extinction.

For human STC is formulated the following regularity kinetics of involutionary processes: after 30 years of age in the human body morphological changes regress in arithmetic progression, and the functions of organs in a geometric one.

Assumption of health as a state redundancy of functions is suggested (26).

The research is devoted to the fundamental issue of medicine and biology – the study of factors limiting the life span of a person. As a model, the system of adaptation of the human body to the forces of natural gravity is chosen, the disadaptation to which manifests itself in falls and everyday injuries. The object of the study was the selection of severe fractures of bone tissue due to fall, taken in the age aspect. Statistical and meta-analytical research methods were used. It is shown that the age-related increase in mortality due to household falls, coming to severe bone fractures, is non-linear and increases in geometric progression. As a result of the coincidence of the age characteristics of bone fragility and age-related kidney function, an assumption is made about the role of involution of the renal tissue in the development of osteoporosis in the elderly and the need for a new approach to the prevention of osteoporosis and domestic injuries (27).

Finally, it should be pointed out that neurodynamic tests show significant divergences among particular people. Different types of responses to the ailments, the range of movements and the effects of structural differentiation are very common and in an obvious way find reflection in the answers variability during the examination. In this regard comparing the results between the examined is impossible. Therefore, the investigators

should draw clinical conclusions from the comparison between the affected and the non-affected sides in the same patient, not between particular examined patients.

It is also obvious that proper interpretation requires essential knowledge of muscular and nervous system. Without it is impossible to understand the validity of the conducted tests, even more essential, to analyse their results.

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