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Inadequacies of the Lasègue test, and how the Slump and Bowstring tests are useful for the diagnosis of sciatica

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Abstract

Diagnosis of sciatica mainly relies on pain reproduction by stretching of the lumbar roots since neurological examination and medical history are usually not sufficient to guarantee diagnosis. The Lasègue test is the most popular method, which starts with the straight leg raising test (SLR). However it is not perfect, and is not always well performed or interpreted. Passive ankle dorsiflexion at the end of the SLR (Bragard test) is more sensitive, but can also remain normal in some cases of sciatica. Other stretching tests can help to recognize lumbar root damage in patients with poorly defined pain in a lower extremity: 1) the Christodoulides test, i.e. reproduction of L5 sciatic pain by a femoral stretch test; 2) the Slump test, performed on a patient in a sitting position, by slowly extending their painful leg then passively bending their neck (or the opposite); 3) the Bowstring test, which requires, at the end of the Lasègue test, once the knee has been slightly flexed, pressing on the course of the peroneal and/or tibial nerves in the popliteal fossea to try and reproduce the exact pain felt by the patient. The combination of all these tests takes less than 2 minutes, and could improve both the sensitivity and specificity of the physical examination for the diagnosis of sciatica. This article is a review of the limitations of the Lasègue/SLR tests and of the efficacy of these other tests for stretching the lumbar roots.

Keywords: sciatica, sciatic, tension, root, Lasègue test, SLR, straight leg raising, Bragard test, Slump test, Bowstring test

Diagnosis of sciatica (L5 and/or S1 nerve root pain) mainly relies on pain reproduction by stretching the lumbar roots since neurological examination and medical history are usually not sufficient to guarantee diagnosis [1]. This extra tension on the nerve increases the root ischemia, which explains the possibility of sciatica through mechanisms other than compression [2]. Other root stretching tests exist that are less well known and less widely validated than the Lasègue test [3]. Systematically performing these tests could improve both the sensitivity and specificity of the physical examination [4]. Compiled after a systematic search on PubMed, this review summarises references concerning both the limitations of the Lasègue test and the value of the Bragard test, Christodoulides test, Slump test and Bowstring test, in the context of disc-related sciatica.

1-Inaccuracies and inadequacies of the Lasègue test

The first limitation of the Lasègue test is that the way it is performed and interpreted differs depending on the author: some only consider it positive if it reproduces the known pain only when the leg is raised between 30° and 70° [5]. Others, faithful to the description given, not by Charles Lasègue, but one of his pupils (Jean Forst), stress that to increase the specificity of the test, once the patient's pain is reproduced by raising their leg straight, you must bend their knee a little, then stretch the sciatic nerve again by ankle dorsiflexion, to verify that the pain returns [5] (Figure 1). This 'complete' Lasègue test confirms that mere passive straight leg raising (Figure 2) has not produced a false positive due to hamstring stretching [6].

Commented [JM1]: "voire avant 45°" n'est-elle pas redondante vu que 30° est avant 45° ?

This ankle dorsiflexion can also be applied at the end of the SLR (knee extended) to stretch the roots further [7]. This is known as the Bragard test (Figure 3). Additional ankle dorsiflexion reduces the angle of the SLR by 9.5 +/- 8.3 degrees (i.e. 21.5 +/- 18.8%) in men and by 15.2 +/- 9.5 degrees (25.9 +/- 13.9%) in women [8]. In a prospective study of 203 sciatica patients without a positive Lasègue test, the Bragard test was positive in 53% of cases, and 73% of these had EMG abnormalities [9].

Care must also be taken during the Lasègue test not to simultaneously medially rotate and/or adduct the limb, as the lateral rotator muscles are then stretched, which can trigger pain due to passive stretching of the piriformis muscle and pressure placed on the sciatic nerve (Freiberg sign).

The second reason is that the relevance of the Lasègue test in the diagnosis of sciatica has often been considered compared to an imperfect gold standard, such as the presence of EMG abnormalities or a herniated disc on imaging. The summary of around one hundred studies has in fact concluded that the EMG is not very sensitive and that it cannot adequately predict the outcome of the sciatica [10]. For example, in a series of 108 clinically typical sciatica patients very probably disc-related (presence of a consistent herniated disc on the CT), the EMG was abnormal only in 42% of cases [11].

Imaging, even MRI, is an even more inadequate gold standard for several reasons: firstly, MRI does not directly demonstrate nerve impairment (apart from nerve tumours); secondly, mechanical lumbar radicular pain can have many causes other than a herniated disc (which an MRI will not show in 12% of cases anyway [12]), and such causes are hard to see or not seen at all on an MRI: constriction of the nerve roots by the foraminal ligaments, stretching of the nerve roots by spondylolisthesis only revealed when standing, adhesions of the nerve roots inside the dura (arachnoiditis) or in the epidural space (wide dural sac syndrome) and predominantly foraminal lumbar stenosis [13]. The fact that the Lasègue test and the other root tension tests are less often positive in the latter context [14] could help explain why the frequency decreases with age, even when a consistent herniated disc is

documented: in a series of 269 sciatica patients with a consistent MRI, the Lasègue test was positive in 100% of cases between 10 and 19 years, 87% of cases between 20 and 29 years, 82% of cases between 30 and 39 years, and the probability of a positive result in people over 60 was 5.4 times lower [15].

It is therefore inappropriate to conclude that a positive Lasègue test is not a specific sign of sciatica, on the pretext that it may be positive when the MRI does not show a herniated disc, and on the pretext that its sensitivity is poor because many patients with a bulging disc have a negative Lasègue test: in the study by Capra et al, the sensitivity of the Lasègue test for the diagnosis of sciatica was only estimated to be 36% because two-thirds of the herniated discs were not associated with a positive Lasègue test [16].

These gross errors of logic have been repeated in meta-analyses carried out by non-clinicians [17] who confuse the issue of a positive sciatica diagnosis with the issue of whether or not surgery to excise a herniated disc is indicated. This logic is only appropriate for surgeons legitimately asking themselves whether to operate, taking into account the risks of surgery, and reasoning only based on compression mechanisms (ignoring the excessive stretching of the nerve roots, which is not seen on the imaging [2]). Amalgamating most of the studies mainly referring to the surgical findings [18], the sensitivity of the Lasègue test increases to 84% (72 to 92%) and its specificity to 78% (67 to 87%), and the efficacy of the femoral stretch test is even better, with a sensitivity of almost 100% (40 to 100% depending on the study) and a specificity of 83% (52% to 98%) [19].

Retaining only patients with a clinical picture very suggestive of radicular pain, it has already been concluded, after a meta-analysis of the 4 best available studies, that it was the sensitivity of MRI in detecting nerve root impingement in the lumbar area that was poor (only 25%), although its specificity (92%) was very good [20].

The third (and much better) reason for considering the Lasègue test as imperfect is that, even if done well, it can give a false negative due to: a) hyperlaxity; b) conversely, stiffening of the hip: for significant tension on normal nerve roots, there must be a thigh flexion on the pelvis of at least 60° [21], even if, when the nerve is already sensitized, a smaller angle may be enough to trigger the pain; c) an anteversion or incidence of the pelvis meaning that in the decubitus position a hip flexion of more than 90° is not sufficient to stretch the nerve enough to reproduce the radicular pain. These cofactors could help explain why the Lasègue test is positive slightly more often in men (1.3 times more) [15]; d) a weaker adhesion of the sciatic nerve to the neighbouring structures (in particular to the fascia of the gluteal muscles in the buttock) in certain patients, causing less sciatic nerve traction. Endoscopic treatments of pelvic-femoral syndromes (such as 'piriformis syndromes') have documented the frequency of sciatic nerve attachment to these muscles by various fibrous or fibro-vascular bands [22], which imaging, even MRI, does not show, in the same way that it does not show or poorly shows the foraminal ligaments [23], while resection of these bands brings significant relief in 80% of patients [22].

2-There are other tests in addition to the Lasègue/SLR test to stretch the sciatic nerve.

These other clinical nerve root stretching tests can reveal a pathology in sciatica cases where the Lasègue test is negative, and they improve the sensitivity of the physical examination. Even if the Lasègue test is positive, systematically performing these tests could provide more specific information about the sciatica.

2-1: Christodoulides test

This consists of performing a femoral stretch test (Figure 4) in patients with signs suggestive of L5 impairment. Indeed, in certain patients whose L5 sciatica results from traction in the recess, the rapid passive flexion of the leg onto the thigh in the decubitus position can, by stretching the psoas, stretch the L5 nerve root more than with the Lasègue test, although the anatomical explanations for this phenomenon have not been studied in depth. In the study of the author who described it, a herniated disc in the L4-L5 recess was found in the 40 patients for whom this test was positive [24].

2-2: Slump test

2-2-1: Procedure

As early as 1881, Lazarevic described the possibility of reproducing the patient's sciatica in a sitting position, extending their knee on the painful side [25].

The Slump test (Figure 5) consists of increasing the sensitivity of this test by adding a flexion of the cervical spine to stretch the dura mater and the nerve roots [26-27] (even if the flexion of the neck only shortens the downward course of the sciatic nerve to the thigh by 2.6 mm when the leg is raised [28]), as the extension of the neck causes relaxation. Compared to extension, the spine flexion reduces the knee extension angle by 6.6 +/- 4.7 degrees (i.e. 18.7% +/- 17.5%) in men, and by 5.4 +/- 5.8 degrees (17.6% +/- 23.7%) in women [8]. It is not the lumbar dorsal kyphosis that is responsible for the significant mobilization of the sciatic nerve, but rather the traction of the meningeal layer (dura mater) and the CNS [29]. A study comparing the results of the Slump test (supplemented by ankle dorsiflexion) in 40 women with no neck pain, and 20 suffering from whiplash, showed that the angle of the Slump

test was lower in the latter, which suggests acquired cervical meningeal adhesions after the trauma [30].

This Slump test was proposed in the 1980s [31-32], and was soon popular because of its very good intra and even inter-observer reproducibility (k = 0.83 to 0.89) [26], as good as that of the Lasègue test [33].

There are two ways to conduct it, depending on whether a binary result is sought (positive or negative), or quantifiable result (the measurement of the leg extension angle was much more precise than that of the maximum neck flexion), and these two methods do not have the same impact on meningeal traction [34].

1) in a seated patient whose painful leg has been placed horizontally (90°), the sciatic pain is reproduced by passive flexion of the cervical spine (this procedure enables binary results). It is not always possible to perform the Slump test in this way: in the most severe forms of sciatica, some patients, when sitting, cannot bear a 90° leg extension. In a study of 77 sciatica patients, this was the case for 28% of patients, some of which, because of the pain induced during the hip extension, reacted by drawing back the torso, i.e. extending the lumbar spine (or even dorsal spine) to reduce the stretch on the dura mater and sciatic nerve (this reaction is called a 'Flip test') [35].

2) again, in a seated patient, and with the cervical and dorsal spine bent, the leg is passively extended until blocked by the pain, measuring the angle in relation to the initial vertical position [36]. This second method quantifies the 'severity' of the Slump sign, but could be less specific if the patient is not told that it is their known pain that must be triggered and not pain caused by stretching the hamstrings. Indeed, in a study of 84 healthy subjects with a mean

age of 23 years not complaining of lower back pain or radicular pain, pain at the root of the thigh was triggered during this Slump test in 33% of the patients when this was done by first bending the head to the maximum, then gradually extending the knee, and from a mean angle of 15.1° in relation to the maximum extension (12.3 to 19.1°) [37]. Furthermore, even in the absence of pain, feelings of stretching, tension or traction are reported by 80% of patients, which disappear if, instead of the initial position with the neck bent, it is then hyperextended [38].

Like the Lasègue test, the sensitivity of the Slump test can be increased by adding a passive ankle dorsiflexion [26], and/or a medial rotation of the limb [39].

The Slump test differs from the Lasègue test in two ways: 1) there are no differences between men and women in terms of the level of tension induced during the Slump test [40]; 2) a Slump test on both sides (i.e. by placing both of the seated person's legs in an extended position instead of only the symptomatic leg, before bending their head) decreases the feeling of tension or pain on the side of the sciatica [41], minimizing the 'twist' exerted on the dura mater and the painful nerve root.

2-2-2: Sensitivity and specificity of the Slump test

A study of 34 African patients suffering from lumbar radicular pain who had an MRI for a suspected herniated disc, and in whom a Lasègue test and Slump test were performed, concluded that by taking the presence of a herniated disc consistent with radicular pain as the gold standard, the Lasègue test was slightly more sensitive than the Slump test (87.5% versus 80%) but the Slump test was more specific (71.4% versus 42.9%) [42]. Conversely, in a Turkish study of 75 patients with lower back pain or lumbar radicular pain, 38 of whom had a herniated disc on the MRI, the Slump test was more

sensitive for confirming the presence of a herniated disc (84%) than the SLR (52%), and their specificity was similar (83% versus 89%) [43]. The same was true in a cohort of 99 Swedish sciatica patients, whose mean age was 59 years, all disc-related according to the MRI. The most frequent sign was a positive Slump test (67/99 patients), whereas the SLR was positive only in 50/99 patients, and the femoral stretch test only positive in 7/99 patients [44].

As for the Lasègue test, one reason for the Slump test giving a false positive is the acquired adhesion of the sciatic nerve trunk to the hamstrings not immediately after hamstring healing: 57% of 12 rugby players in this case had a limitation during the Slump test [45], despite a popliteal angle identical to that of 12 other rugby players without a past hamstring injury. Conversely, the specificity (if the gold standard is a herniated disc) of the Slump test could be better than some studies have suggested because, in a study that stratified the imaging of sciatica patients, the sciatica was reproduced during the Slump test in 49/52 (94%) patients with a herniated disc, 32/41 (78%) with disc protrusion, and 9/12 (75%) without a known bulging disc, but perhaps with adhesions in the spinal canal [46].

While the Slump test is defined by the reproduction of sciatica during the test then the increase in pain when ankle dorsiflexion is added, the correlation with a positive Bragard test (pain during SLR further increased by ankle dorsiflexion) is good (kappa = 0.69), although not perfect [36]. This shows the impact of the sitting position (and pelvis) on the 'pre-stretching' of the nerve, and also the relevance of the Slump test, which is not superfluous to the Lasègue and Bragard tests.

2-2-3: Slump test outcomes after infiltrations

Several radicular tension tests, before and 10 minutes after an epidural infiltration of Marcaine and methylprednisolone, on 10 patients with radicular pain related to a herniated disc, showed that the results of both the Slump test (improved in all cases, with all pain disappearing in 7/10 cases), and the Lasègue test (improvement in the angle of 29° +/- 12° (or 54% on average)) were different after the infiltrations [47].

In a study on the outcome after one year of 100 sciatica patients (84% of whom had signs of disc herniation on the imaging) given foraminal steroid injections (where only 27% of the 100 patients experienced at least 50% relief from their radicular pain after three weeks), the only clinical or radiological sign predicting such a good result was a positive Slump test (in 67% of patients): 33% of patients with a positive Slump test experienced improvement, versus only 15% of those with a negative Slump test [48].

2-3: Bowstring test

Normally, moderate nerve pressure can trigger paraesthesia but little or no pain. On the other hand, on an already sensitive nerve root, both traction stress and moderate pressure [49], can trigger nerve pain [50], in particular when the nerve or its branches pass through sensitive points (Valleix points). This acquired sensitivity to mechanical stress can exist in the absence of EMG signs of axonal impairment [51] or nerve compression due to a bulging disc (for example they are also observed in the context of radicular pain induced by lumbar stenosis [52]).

The Bowstring or Cram test, was originally described in 1888 by Gowers. It consists of reproducing the patient's known sciatic pain when pressure is applied to the peroneal nerves, behind and/or under the head of the fibula, and/or tibial nerves in the popliteal fossa [5], on ‘pre-stretched' nerves at the end

of the Lasègue test (when the knee is relaxed a little before performing an ankle dorsiflexion to confirm the pain trigger) [49] (Figure 6).

This test is thought to be more specific, but less sensitive, than the Lasègue test and Slump test. However, in a prospective study of 50 patients going on to have surgery for sciatica due to a herniated disc, while the Lasègue test was positive in 71% and the contralateral SLR positive in 21% of the patients, the Bowstring test was also positive in 69% of the patients [53].

One of the limitations of this test could be the difficulty to standardize it. Even though, in pain-free patients, the interobserver reproducibility of inducing sensitivity by pressure on the peroneal, tibial and sciatic nerves in the knee was only 49%, 37%, and 60% [54], the reproduction by two examiners of pre-existing sciatic pain during the Bowstring test in 20 sciatica patients was much better, with kappa scores of 0.8 [49].

In a study of 45 patients with low lumbar radicular pain, pressure on at least two of these three sites triggered the known pain in 25/45 patients (therefore sensitivity was at least 55%). The SLR or Slump test was indeed positive in 17 of these 25 patients, but only the Bowstring test was positive in 8/45 cases (18%). In the 20 patients with a negative Bowstring test, both the Lasègue test and Slump test were only positive in 3/20 patients [49]. This seems to confirm the relevance of carrying out several nerve root stretching tests to increase the sensitivity, and no doubt also the specificity of the physical examination for suspected sciatica, even if past studies have not attempted to calculate their values for combined tests.

The efficacy of the physical examination for sciatica improves when several clinical tests are combined [18]. Unsuitable additional examinations could be replaced by artificial intelligence methods [55] grouping signs from the medical history and physical examination into clusters, including root tension tests, to identify associations and determine a 'centroid', confidently

confirming the sciatic impairment. These methods could then highlight the weaknesses of paraclinical gold standards previously used, and assess their relevance for diagnosis.

Extensive prospective studies of patients suffering with sciatica need to be conducted, especially when disc-related [56] or due to stenosis [57], to better assess the improvement in sensitivity and specificity offered combining the different tests: in addition to the Lasègue test (and its sensitized variant, the Bragard test), systematically practising the Bowstring test, Christodoulides test and Slump test takes less than 2 minutes. This combination of tests could also more effectively predict the outcome of the sciatica [58]. One last reason for such studies would be to test the hypothesis that the sciatica triggered by pressure on the peroneal nerve or tibial nerve at the knee is specific to L5 or S1 impairment, respectively.

Although epidural infiltrations are now considered less effective [59], the improved clinical expertise of rheumatologists for diagnosing sciatica could help patients and the community at little cost.

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Legends to figures

Figure 1: The complete Lasègue test consists, once the patient's pain is reproduced by raising their leg straight, of bending their knee a little, then stretching the sciatic nerve again by ankle dorsiflexion, to verify that the pain returns.

Figure 2: The first part of the Lasègue test consists of reproducing the patient's pain by passively raising their straight leg until the onset of the known pain (which is manifested by the patient stopping, often contracting the hamstrings to relieve the pain). This test is often called SLR (straight leg raising).

Figure 3: The Bragard test consists of increasing the sensitivity of the SLR by adding at the end of it a passive ankle dorsiflexion to further stretch the sciatic nerve.

Figure 4: The femoral stretch test must be performed without lifting the patient's thigh above the horizontal position (to avoid extending the hip and mobilizing the pelvis and spine, which greatly reduces the specificity of the test), but quickly flexing the leg onto the thigh to stretch the femoral nerve abruptly. When it triggers sciatic pain and not femoral pain, this is known as the Christodoulides sign [24].

Figure 5: The Slump test consists of reproducing the sciatic pain in a seated patient, either a) by first placing the legs horizontally, then passively flexing the cervical +/- dorsal spine; or b) by passively flexing the cervical spine and then gradually passively extending the painful leg until the known pain is reproduced [34-41].

Figure 6: The Bowstring test consists, during the second stage of the Lasègue test, once the nerve is pre-stretched, of trying to reproduce the patient's known pain, by pressing the thumb on the peroneal nerve (behind and under the head of the fibula), and on the tibial nerve (in the middle of the popliteal fossa) [49,53].