

## SPECIAL COMMUNICATION

### Literature review and update of lower limb neural mobilization

### Revisión de la literatura y actualización de la movilización neural en el miembro inferior

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#### Abstract

*Objectives:* summarize the available literature descriptions of neural mobilization (NM) techniques and neural provocation tests (NPT) for the Lower Limb (LL).

*Material and Methods:* compilation of data was performed in May 2016 using MEDLINE data base, Google Scholar and the library of the European University of Madrid. After application of inclusion/exclusion criterions 5 books and 14 journal publications were found to be of interest and used during data extraction.

*Results:* a list of 8 different LLNM techniques are applied in a rhythmic alternating oscillatory cycle fashion, starting in the initial position from where the therapist proceeds to move the limb in order to achieve a final position. LL NPTs are useful tools for differential diagnose and selecting the proper LLNM procedure. There is no consensus about the time frame of repetition intervals or amount of tensile strength during NPT never the less it is found to normally be performed at a rate of 2-4 seconds per complete cycle of movement, during 1-5 minutes, 3-5 times a week.

*Conclusions:* LLNM treatment techniques all thou increasingly popular in clinical practice are found to be frugally described and lack proper standardization in regards to therapeutic dosification.

**Key Words:** neural tissue, physical therapy, manual therapy.

#### Resumen

*Objetivos:* Revisar la bibliografía disponible sobre la movilización neural (MN) y respectivas pruebas de provocación neurales (PPN) en los miembros inferiores (MI).

*Métodos:* la recopilación de datos se realizó en el mes de mayo del año 2016 usando la base de datos MEDLINE, Google Scholar y la biblioteca de la Universidad Europea de Madrid. Posterior a la aplicación de criterios de inclusión y exclusión se seleccionaron 5 libros y 14 publicaciones de revistas para la extracción de datos.

*Resultados:* se obtuvo una lista de 8 técnicas de MN que se aplican de una manera cíclica y oscilatoria, a partir de una posición inicial desde la que el terapeuta procede a mover el MI con el fin de alcanzar una posición final. Las PPN del MI constituyen herramientas útiles para el diagnóstico diferencial y la selección del procedimiento adecuado de MN del MI. No fue posible encontrar consenso literario sobre el marco de tiempo de los intervalos de repetición o la cantidad de fuerza tensil que se debe aplicar durante la MN y los PPN. Normalmente se estilan aplicaciones de 2-4 segundos por ciclo completo de movimiento, durante 1-5 minutos, 3 -5 veces a la semana.

*Conclusiones:* las técnicas de MN son cada vez más popular en la práctica clínica, sin embargo se encuentran descritas con frugalidad y carecen de estandarización adecuada en relacion a su dosificación terapéutica.

**Palabras Clave:** tejido neural, terapia física, terapia manual.

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## Introduction

The nervous and musculo-skeletal systems constitute a fully integrated anatomical complex capable of mutually causing malfunction and disease in one another through shared trauma or by reciprocal biochemical signaling due to numerous medical conditions<sup>1</sup>.

The nervous system (NS) is fully surrounded and embedded in the musculo-skeletal apparatus; and as a consequence of this anatomical disposition the NS constantly adapts its physiology, shape, and dimensions to the resulting effect of musculo-skeletal segmental positioning during active and passive movements<sup>2,3</sup>.

Never the less in normal physiologic conditions the neural tissue is prepared to perform this biomechanical adaptation to musculo-skeletal movement through coupled elongation, excursion and gliding movements that are oriented to the location of mechanical tension gradient increase<sup>4</sup>. In the presence of a wide spectrum of diseases and traumas an alteration of the neural biomechanical properties of the neural tissue can become present. This alteration may lead to neural tissue edema, ischemia, hypoxia, fibrosis and a consequent lost of neural connective tissue movement also known as neurodynamic dysfunction.

Regardless of the underlying construct the theoretical purpose of the neural mobilization (NM) manual physical therapy techniques is to restore the normal biomechanical function of the affected neural tissue. This is achieved by the performance of specifically designed active and passive movements that take place in the involved limb or spine segment.

It is widely believed that this biomechanical function restoration produces a positive impact in the overall resolution of the underlying pathology and its potential to generate neuropathic pain by fighting co-morbidity, and restoring normal neural physiology<sup>5,6</sup>. This investigation is based on the following objectives:

- Summarize the available literature descriptions of NM techniques for the Lower Limb (LL)
- Describe the standardized neural provocation tests (NPT) used for NM assessment.
- Evaluate the importance of lower limb neural mobilization (LLNM) journal publications in regards to its standardization, generalizability, and effect through qualitative assessment of reported data.

## Material and Methods

Compilation of Data was performed in the month of May 2016 using MEDLINE data base, Google Scholar and the library of the European University of Madrid. A total of 9 books and 32 journal articles were screened; 5 books and 14 journal publications were found to be of interest and used during data extraction.

Inclusion criteria of literature was that the analyzed data had to belong to primary or secondary sources of information which included milestone text, books and research studies (specially RCTs) available through key term searches at any of the mentioned data base management systems employed for this reviews literature research.

The exclusion criterion of data was performed when an absence of any mentioned inclusion criteria was detected.

Key words and terminology employed for data base search and navigation during this reviews data collection process were all terms directly present in the MESH, Pubmed, Google Scholar, and Medline that were considered strongly related to this investigation traced objectives. Searched key terms comprehend the following list: neural mobilization, lower limb neural mobilization, lower limb neurodynamics, neural tissue mobilization, neural tissue provocation tests, manual therapy, nervous system, physiotherapy, lower limb neural provocation test, nerve gliding, nerve stretching, musculo-skeletal, neurogenic pain, neuralgia, central sensitization, neuropathic pain, Tibial NM, Saphenous NM, Sciatic NM, Slump, Peroneal NM, Obturator NM, Sural NM, Obturator NM; additional search was done using several combinations of this words and phrases.

**Results**

NM or neurodynamics is a terminology originally coined by Shaclock<sup>7</sup> in 1995; it is defined according to Villafañe<sup>8</sup> as “a form of manual therapy that directs force to neural structures through positioning and movement of multiple joints”<sup>8</sup> and all thou the concept of nerve stretching is 2 centuries old, the NM that’s currently employed in clinical practice has only recently been incorporated into medicine and physiotherapy<sup>7,8</sup>. Zamorano<sup>9</sup> states that NM techniques specifically designed to treat LL neural tissue neuro-mechanical deficiencies comprehend the following consist list of passive (Table 1) and active (Table 2) movements:

- 1- Sciatic nerve (N.) NM
- 2- Peroneal N. NM
- 3- Femoral N. NM
- 4- Tibial N. NM
- 5- Femoral N. and Neural axis NM
- 6- Obturator N. NM<sup>9</sup>

**Table 1. Passive LLNM<sup>1</sup> procedures\***

Passive procedure	LLNM	Initial positioning of the subject	Final positioning of the subject	Related anatomy and entrapment areas	clinical and
- Sciatic N <sup>2</sup> , NM <sup>3</sup>		-Straight leg raise and application of plantar-flexion without producing symptoms	-Flexed knee with a foot dorsiflexion component	-Hip displacement -Pelvic outlet syndrome -Pyramidal, obturator and gluteus muscles	
-Femoral N. NM		-Subject is positioned in Slump Knee Bend (SKB): the patient's flexes knee of the affected LL <sup>4</sup> around 90 degrees whilst holding opposite knee in some, but not full, hip flexion.	-SKB initial positioning whilst adding hip extension	-Femoral pinch at the inguinal ligament	
-Neural axis Femoral. NM		-Subject is positioned in Slump Knee Bend with a neck and head flexion component	-SKB initial positioning whilst adding hip extension and simultaneous head and neck extension.	-Femoral pinch at the inguinal ligament -L2-L3 root syndromes	
-Tibial N. NM		-Foot is held in dorsiflexion, eversion and pronation.	- Straight Leg Raise with the therapist's arm on the shaft of the tibia	-Tarsal tunnel -Plantar fasciitis Heel spur -Recurrent hamstring injury -Piriformis area	
- Peroneal N. NM		-Extended knee, plantar flexion/inversion of the affected LL	-Extended knee dorsiflexion and eversion of the affected LL	-Lower lumbar spine - Piriformis area -Superior tibiofibular joint -Lower limb compartments -Ankle extensor retinaculum	
-Sural N. NM		- Affected LL Hip, knee in flexion and ankle in dorsiflexion/inversion.	-Initial positioning whilst adding knee extension.	-Recurrent ankle problems - A component of Achilles tendonitis	
-Saphenous N. NM		-Hip abduction/extension/ external rotation . -Knee flexion -Ankle doriflexion/ eversion	-Initial positioning whilst adding knee extension.	-Post arthroscopy -medial knee pain. May be involved in medial collateral ligament injuries -Pelvic musculature	
-Obturator N. NM		- subject is positioned in Slump Knee Bend	-Slump Knee Bend position and then abduct the hip		

LLNM<sup>1</sup>=Lower limb neural mobilization N<sup>2</sup>= Nerve, NM<sup>3</sup>= neural mobilization, LL<sup>4</sup>= Lower limb, \*= according to milestone literature by Butler and Zamorano,

Table 2. Active LLNM<sup>1</sup> procedures\*

Active procedure	LLNM	Initial positioning of the subject	Final positioning of the subject	Related anatomy and entrapment areas	clinical areas
-Sciatic N <sup>2</sup> . NM <sup>3</sup>		--Subject is positioned in Slump Knee Bend (SKB): the patient's flexes knee of the affected LL <sup>4</sup> around 90 degrees, hip flexion and a head-neck flexion component.	-SKB initial positioning whilst adding knee extension to a simultaneous head and neck extension	-Hip displacement -Pelvic outlet syndrome -Pyramidal obturator and gluteus muscles	
-Femoral N. NM <sup>5</sup>		-Affected Slump Knee Bend sustained standing over the opposite LL	-SKB initial positioning whilst adding hip extension of the affected LL	-Femoral pinch at the inguinal ligament	
-Neural axis Femoral. NM		-SKB as described for the Femoral active NM adding a head-neck flexion component	-SKB initial positioning whilst adding hip extension of the affected LL and head-neck flexion	-Femoral pinch at the inguinal ligament -L2-L3 root syndromes	
-Tibial N. NM <sup>6</sup>		-Sustained leg raise by subjects hands foot is held in dorsiflexion, eversion and pronation, flexed knee (subject positioned in supine)	- Straight knee extension whilst maintaining leg Raise with the aid of subjects both hands	-Tarsal tunnel -Plantar fasciitis Heel spur -Recurrent hamstring injury -Piriformis area	
-Peroneal N. NM <sup>5</sup>		-As described for Tibial NM except for foot in plantar flexion	- Straight knee extension whilst maintaining leg Raise with the aid of subjects both hands	-Lower lumbar spine -Piriformis area -Superior tibiofibular joint -Lower limb compartments -Ankle extensor retinaculum -Recurrent ankle problems	
-Sural N. NM <sup>6</sup>		- Affected LL Hip, knee in flexion and ankle in dorsiflexion/inversion.	-Initial positioning whilst adding knee extension.	- A component of Achilles tendonitis -Post arthroscopy	
-Saphenous N. NM <sup>6</sup>		-Subject standing: place healthy leg in front of the affected limb. The affected LL foot is in dorsiflexion and eversion.	- By flexing healthy LL knee the affected LL saphenous nerve is self mobilised.	-medial knee pain. May be involved in knee medial collateral ligament injuries	
-Obturator N. NM <sup>6</sup>		- Subject is positioned in Slump Knee Bend	-Initial positioning adding hip abduction	-Pelvic musculature	

LLNM<sup>1</sup>=Lower limb neural mobilization N<sup>2</sup>= Nerve, NM<sup>3</sup>= neural mobilization, LL<sup>4</sup>= Lower limb, <sup>5</sup> = extensive variations are reported in milestone literature, <sup>6</sup> = these techniques are combined with slump variations in order to increase tensile intensity over the involved tissue, \* = according to milestone literature by Butler and Zamorano

The techniques are applied in a rhythmic alternating oscillatory fashion, starting in the initial position from where the therapist proceeds to move the limb in order to achieve a final position, only to immediately return the limb to the initial position so that the therapist may repeat the cycle of movement over and over.

There is no consensus about the time frame of repetition intervals, never the less it is found to normally be performed at a rate of 2-4 seconds per complete cycle of movement (Initial-final-initial) during 1-5 minutes 3-5 times a week.<sup>6,10,11</sup>

## Clinical implementation of LLNM

Initially LLNM is intended to be applied in subjects who suffer from painful neurogenic disorders' resulting from an interactive imbalance between the relative movement of neural tissues and their surrounding mechanical interface (mostly formed of musculo-skeletal connective tissue)<sup>6</sup> but most recently LLNM has also been used to treat subjects who suffered neurogenic disorders derived from infectious, metabolic and cerebro-vascular etiologies with positive results<sup>12,13</sup>. The objective of LLNM application is to restore normal physiologic functions to involved tissues through the gliding and tensing of target neural tissue and its surrounding structures.

For the proper application of the LLNM techniques extensive neurological and musculo-skeletal assessment is mandatory. Because of this ineludible matter, the practitioner must be adequately instructed in the general principles of clinical assessments regarding the complete human Nervous and locomotor systems<sup>14</sup>. This extensive content will not be described in the present review do to practical reasons, and to avoid information redundancy; never the less, there are concise assessments in the form of manual tests that are of great importance and clearly worth describing, this tests are known as the neural provocation tests (NPT); which are group of tests closely related to the LLNM application procedures and are based upon the reproduction of neural tissue symptomatology.

According to literature the NPT reproduce neurogenic pain patterns derived from the presence of a neuromechanical dysfunction. The NPT allows the practitioner to indentify a differential diagnosis and where the neural tissue dysfunction is topographically located; this rationale subsequently facilitates the proper selection of the LLNM technique to perform, as well as the tensile strength needed in order to achieve the desired effect<sup>15,16,17</sup>.

LLNM is heavily based on the LL NPT procedures with a marked distinction that lies within the fact that NPT are intended to diagnose neural dysfunction through pain reproduction resulting from the application of movement similar to the LLNM but with a high enough level of mechanical tensile strength. NPT are applied normally in a onetime occasion during initial assessment for diagnostic purposes' only, mean while the LLNM is done repetitively without symptom provocation as a treatment for longer periods of time, there for, both NPT and LLNM should not be confused <sup>18,19</sup>(Table 3).

Table 3. NPT<sup>1</sup> for lower limb assessment \*

Active procedure	LLNM	Initial positioning of the subject	Final positioning of the subject	Related anatomy and entrapment areas	clinical and
- Sciatic N <sup>2</sup> , NM <sup>3</sup>		--Subject is positioned in sting Slump Knee Bend (SKB): the patient's flexes knee of the affected LL <sup>4</sup> around 90 degrees, hip flexion and a head-neck flexion component.	-SKB initial positioning whilst adding knee extension to a simultaneous head and neck extension	-Hip displacement -Pelvic outlet syndrome -Pyramidal obturator and gluteus muscles	
-Femoral N. NM <sup>5</sup>		-Affected Slump Knee Bend sustained standing over the opposite LL	-SKB initial positioning whilst adding hip extension of the affected LL	-Femoral pinch at the inguinal ligament	
-Neural axis Femoral. NM		-SKB as described for the Femoral active NM adding a head-neck flexion component	-SKB initial positioning whilst adding hip extension of the affected LL and head-neck flexion	-Femoral pinch at the inguinal ligament -L2-L3 root syndromes	
-Tibial N. NM <sup>6</sup>		-Sustained leg raise by subjects hands foot is held in dorsiflexion, eversion and pronation, flexed knee (subject positioned in supine)	- Straight knee extension whilst maintaining leg Raise with the aid of subjects both hands	-Tarsal tunnel -Plantar fasciitis Heel spur -Recurrent hamstring injury -Piriformis area	
- Peroneal N. NM <sup>5</sup>		-As described for Tibial NM except for foot in plantar flexion	- Straight knee extension whilst maintaining leg Raise with the aid of subjects both hands	-Lower lumbar spine - Piriformis area -Superior tibiofibular joint -Lower limb compartments -Ankle extensor retinaculum	
-Sural N. NM <sup>6</sup>		- Affected LL. Hip, knee in flexion and ankle in dorsiflexion/inversion.	-Initial positioning whilst adding knee extension.	-Recurrent ankle problems - A component of Achilles tendonitis	
-Saphenous N. NM <sup>6</sup>		-Subject standing: place healthy leg in front of the affected limb. The affected LL foot is in dorsiflexion and eversion.	- By flexing healthy LL knee the affected LL saphenous nerve is self mobilised.	-Post arthroscopy -medial knee pain. May be involved in knee medial collateral ligament injuries	
-Obturator N. NM <sup>6</sup>		- Subject is positioned in Slump Knee Bend	-Initial positioning adding hip abduction	-Pelvic musculature	

LLNM<sup>1</sup>=Lower limb neural mobilization N<sup>2</sup>= Nerve, NM<sup>3</sup>= neural mobilization, LL<sup>4</sup>= Lower limb, <sup>5</sup> = extensive variations are reported in milestone literature, <sup>6</sup> = these techniques are combined with slump variations in order to increase tensile intensity over the involved tissue, \* = according to milestone literature by Butler and Zamorano

In regards to the protocol and the manner LLNM is applied, the existing literature exhibits a lack of standardization. There is an extensive variability found on the existing randomized clinical trials (RCT) over the treatments time frame subject, how much tensile strength should be applied and the quantity of rhythmic oscillatory repetitions<sup>6,10,11</sup>. The only universally standardized application principle (besides from the fashion of application in its self) is that subjects symptoms should be strictly avoided at all moments during treatment. This is achieved by a great deal of communicative interaction between the subject and the therapist and the performance of a gentle and precise hands-on technique by the practitioner<sup>9</sup>.

## Discussion

Literature regarding RCTs that properly evaluate standardized LLNM and its effect on in-vivo human subjects is extraordinarily scarce; making deeper discussion of LLNM generalized clinical efficacy not possible in order to avoid the generation of inconsistent opinions potentially prone to bias <sup>6</sup>.

Milestone LLNM authorship related to the intellectual production of scientific literature which describes standardized LLNM and NPT procedures was traced down to only 2 main recent authors: Butler<sup>18</sup>, and Zamorano<sup>19</sup>. Both these authors share a great deal of similar stand points that are observed clearly through their description of techniques, physiology, pathophysiology, and neuromechanic assessment.

It is important to mention that Butler and Zamorano performed an acknowledgeable pioneering work related to the development and literary descriptions of the LLNM techniques which is believed to have caused a direct influence over the increasing popularity of NM in clinical practice. This rationale is consistent to the findings of their literature descriptions of LLNM procedures to be an almost omnipresent theoretical construct in most RCTs centered on upper quadrant NM and LLNM.



This reviews findings are consistent to the current limited number of RCTs that investigate LLNM observed in the MEDLINE database, Goggle Scholar and Pubmed, which clearly support ELLis and Hing,<sup>6</sup> Vigotsky and Bruhns<sup>20</sup>, observations of a vast lack of LLNM RCTs. The present investigation findings promote the ongoing need for scientific literature resulting from LLNM RCTs that apply standardized LLNM and LL NPT.

## Conclusions

LLNM treatment techniques all thou increasingly popular in clinical practice are found to be frugally described and lack proper standardization in regards to its therapeutic dosification. The most complete literature description of LLNM procedures was related to the authorship of Butler and Zamorano. A review of relevant RCTs centered on LLNM reveals an overall positive effect and the imperative need for most robust standardized research on LLNM.

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