



# Electromyography activity and muscle strength after treatment with neural mobilization: a systematic review

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## ABSTRACT

**Introduction:** Historically skeletal muscle strength has been the subject of numerous scientific investigations. Which, besides defining its role in health and disease process also identified neuromuscular mechanisms to modify it. Another interesting point is that in recent decades, authors have suggested that neural mobilization techniques can modify the neuromuscular physiology, however, little is known about its effects on muscle strength. **Objective:** To systematically investigate the effects of neural mobilization techniques on muscle strength. **Methods:** A systematic review performed in Google Scholar databases, Latindex, Lilacs, Pubmed and Scielo, through the descriptors: Muscle Strength, Muscle Contraction, Neural Mobilization and Neurodynamics Mobilization. Transverse and longitudinal controlled studies were included. Studies testing the neural mobilization of the muscle contraction force or humans or animals healthy or to peripheral nerve injury. The selected studies were published between the years 2010 and 2014 in national and international journals with Qualis between B1 and B2 according to an evaluation of the top professional development coordination. **Results:** The screening process resulted in the identification of 70 studies, of which only five not fit the eligibility criteria. Selected manuscripts indicated acute and chronic effects of neural mobilization on muscle strength in healthy volunteers with peripheral nerve damage by leprosy and rats with sciatic neuropathy. **Conclusion:** The results of this study indicate positive effects of neural mobilization in relation to the recruitment of muscle fibers, increasing strength and maintaining muscle strength in healthy volunteers and the peripheral nervous system injury.

**Keywords:** Muscle strength, Muscle Contraction, Nervous System, Physical Therapy Modality.

## INTRODUCTION

Neural mobilization (NM) is a set of tensioning and sliding techniques which aims to reestablish neurodynamic functions, through the application of mechanical loads, which are closely related to the morphology, biomechanics and physiology of the neural tissue.<sup>(1,2)</sup> However, variables such as the magnitude of the load, speed and the stretch of time, are still factors which need better clarification in order to obtain appropriate response, since both over tension and little mobility, may be deleterious to both the nervous system and adjacent structures.<sup>(2,3)</sup>

Functionally, the neurodynamic properties allow the nervous tissue to adapt to the biomechanics of the nearby tissues, as well as the human motricity.<sup>(1,3)</sup> This is because failures in these mechanisms may result in injury, edema, ischemia, fibrosis, reduced elasticity, nerve conduction velocity and axoplasmic flow.<sup>(1,4)</sup> Together, these changes may result in tissue damage and neuromuscular disorders, particularly those related to human movement.<sup>(1-3)</sup> Thus, therapeutic

resources aimed at health of neural tissue must be identified, tested and validated.

In this regard, authors suggest the NM as a measure of prevention, evaluation and treatment of neurodynamic disorders<sup>(2)</sup>, considering that different biomechanical levers cause tension and stretching of the peripheral neural tissue.<sup>(4,5)</sup> In this respect, the literature<sup>(1-4)</sup> indicates that the studied technique may reduce tack, improve elasticity, increase the dispersion of harmful fluids as well as adequate blood flow in the neural tissue. Another evidence<sup>(6-8)</sup> still point improvement in axoplasmic flow, conduction velocity of the neural system and modulation of muscle tone. Physiologically these responses are related to neuromuscular health.<sup>(4)</sup> It is worth noting that the nervous system is a key part in maintaining the plasticity, tropism and most the biological processes involved in the recruitment of muscle fibers, which leads us to suggest that the NM may influence the production of skeletal muscle strength.<sup>(9)</sup>

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**Financial support:** none.

**Submission date 21 August 2016; Acceptance date 14 November 2016; Publication online date 28 November 2016**





Another interesting point is that according to our bibliographical review, there are no revisions addressing the topic in question.<sup>(1,2)</sup> Therefore, since muscular strength is known as one of the main components of physical fitness related to health, quality of life, functional performance during activities of daily living and sports activities,<sup>(10)</sup> the present study aimed to systematically investigate the effects of neural techniques mobilization on the muscular strength of human beings and animal models, healthy or with injury of the peripheral nervous system.

## METHODS

### Research Type

The present study is characterized as a systematic review of original studies published in journals indexed in the electronic databases LILACS, LILACS, PUBMED, PEDRO, REDALYC and SCIELO, on the effects of neural mobilization techniques on muscle strength.

### Eligibility Criteria

The following were considered eligible: 1) controlled primary empirical studies, with a cross-sectional or longitudinal design, 2) studies which evaluated the muscular strength of humans or animals, healthy or with injuries in the peripheral nervous system, after intervention with neural mobilization, 3) study which described the methods of evaluation of muscle strength, 4) articles published in national or international journals, with Qualis between A1 and B3 in area 21, according to the assessment of the coordination of higher education personnel, and 5) to be published until August 2015. Thus, abstracts published in congresses, monographs, dissertations, commentaries, reviews and observational and case studies were not considered eligible.

### Search Engine

The review was developed by independent authors between March and August 2015. For the identification of the manuscripts, keywords were selected from descriptors in health sciences and previously published reviews about the subject. Thus, we use as cross-descriptors, or, individually in the fields "words", "subject descriptors", "title words", "title" and "abstract", the following keywords: "Neural Mobilization" AND "Muscle Strength", "Neural Mobilization" AND "Muscle Contraction", "Neurodynamics Mobilization" AND "Muscle Strength", "Neurodynamics Mobilization" AND "Muscle Contraction", "Neural Mobilization" OR "Neurodynamics Mobilization".

### Data Selection and Extraction

The process of screening the studies was initially done by reading the titles. Subsequently, duplicate articles were excluded and titles and abstracts were read in order

to verify if they met the eligibility criteria of the present study. The articles which met the established criteria were retrieved to read the full text, reassessment of the eligibility criteria and extraction of data regarding the author and year of publication, (b) objectives, (c) sample and method of evaluation muscular strength, (d) intervention and (e) results of muscle strength, Table 1. Finally, the references of the main studies included in this review were evaluated, aiming to verify the existence of eligible articles not identified in the searches in the selected databases. Figure 1 summarizes the process of screening and selection of studies.

## RESULTS

The search in the databases from the isolated descriptors (Neural Mobilization and Neurodynamic Mobilization), resulted in 487 references identified. However, the intersection of the words mentioned above with the descriptors (Muscle Strength and Muscle Contraction) culminated in the identification of 05 articles (LILACS), 02 (PUBMED), 03 articles (SCIELO) and 01 article (PEDRO), totaling 11 references initially by title, in which, one was excluded for duplicate between the databases PEDRO and PubMed and 03 excluded by title, objective and abstract due to the absence of the eligibility criteria. Therefore, there were 7 articles, which were analyzed in full. Regarding these articles mentioned above, 02 were excluded, the first, because it was a case study involving more than one type of intervention and the second, because it did not evaluate the outcome of interest in the present study. Finally, 05 manuscripts<sup>(11-15)</sup> were included in this review (Figure 1).

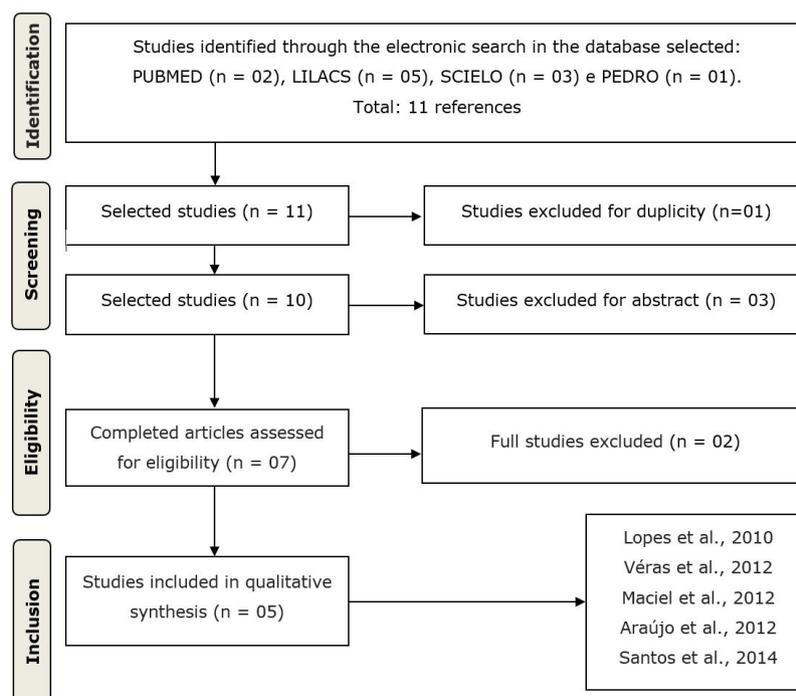
All studies selected for this systematic review were produced in Brazil and published in national and international scientific journals between 2010 and 2014. Regarding the language, two articles<sup>(12,15)</sup> were published in English. Regarding the journals Qualis in which we retrieved the articles, this one varied between B1 and B2, indicating good quality of the articles. In summary, we can see in Table 1 the characteristics of studies for the objective, methodology, studied population, assessment, intervention, main results and Qualis CAPES.

Regarding the studies, only one of them did not directly objectify the evaluation of muscle strength after intervention with neural mobilization.<sup>(15)</sup> Regarding the other features, three longitudinal manuscripts, in which, one of them it was characterized as experimental study<sup>(15)</sup>, which evaluated rats subjected to sciatic neuropathy, neuropathy simulation and intact animals. The other two studies were clinical research, one randomized clinical trial<sup>(14)</sup> and the other<sup>(12)</sup> quasi-experimental study involving patients with leprosy. Regarding the two cross-sectional studies,<sup>(11,13)</sup> one of them is designed as randomized clinical trial.<sup>(13)</sup> All studies were controlled, however, only two obtained sufficient sample.<sup>(12,15)</sup> The size of samples from clinical studies ranged between 10 and 56 participants, in which two studies<sup>(13,14)</sup> evaluated young

**Table 1.** Clinical characteristics of the studies selected for review.

Reference	Objective	Sample and Assessment	Intervention	Results	Qualis
Lopes et al., (2010) <sup>11</sup>	To evaluate the acute effect of muscle stretching and NM on the strength of the quadriceps muscle.	39, young adult volunteers, healthy and sedentary, randomized to <b>GNM</b> (age 21.2 ± 2.4 years), <b>GSS</b> (age 23.2 ± 2.9 years) and <b>CG</b> (age = 21.9 ± 2.5 years). <b>Assessment:</b> electromyography.	<b>GNM:</b> 1 session of 1 minute NM to the femoral nerve vs. <b>GSS:</b> static stretching, with 3 sets of 30 seconds and <b>CG:</b> no intervention.	Increased muscle strength in GNM and decreased strength in GAE.	B2
Véras et al., (2012) <sup>12</sup>	To evaluate the effect of NM technique on the electromyography function, degree of disability and pain in patients with leprosy.	56 leprosy patients, common peroneal nerve injury, weakness of the tibialis anterior muscle, randomized into <b>GNM</b> (47.83 ± 12.84) and <b>GC</b> (age 46.30±15.04 years). <b>Assessment:</b> electromyography.	<b>GNM:</b> 18 NM sessions for lumbosacral and sciatic nerves, 3 times per week, with 3 sets of 20 oscillations per minute, totaling 3 minutes vs. <b>CG:</b> 18 conventional physiotherapy sessions with flexibility exercises, strengthening with progressive resistance, electrotherapy and home exercise guidelines for flexibility and strength.	Increased electromyographic signal and muscle strength in GNM.	B1
Maciel et al., (2012) <sup>13</sup>	To verify if after NM there are changes in recruitment, strength and muscle fatigue of the flexor muscles of the wrist and fingers.	10 voluntary, healthy, aged between 18 and 25 randomized to <b>MAGOG</b> and <b>GOG</b> . <b>Assessment:</b> load attached to the handgrip dynamometer and electromyography.	<b>MAGOG:</b> 1 session of 4 minutes NM for median nerve vs. <b>GOG:</b> no intervention.	Increase in peak muscle strength and increase in muscle fiber recruitment in MAGOG.	B2
Araújo et al., (2012) <sup>14</sup>	To evaluate hand strength in healthy individuals submitted to NM intervention.	20 volunteers, asymptomatic age 19.5 ± 0.92 years, were randomized to <b>G1</b> and <b>G2</b> . <b>Assessment:</b> analog handgrip dynamometer.	<b>G1:</b> 1 session of 1 minute of NM to the median, radial and ulnar nerves vs. <b>G2:</b> placebo conventional stretching.	There was no change in muscle strength.	B1
Santos et al., (2014) <sup>15</sup>	To test the hypothesis if the NM technique reverses neuropathic pain, improving pain modulation systems mediated by endogenous opioids.	25 male Wistar rats submitted or not to nerve injury and randomly grouped into <b>G1, G2, G3, G4</b> and <b>G5</b> . <b>Assessment:</b> electromyography.	<b>G1:</b> 10 NM sessions to sciatic nerve, with 5 series of 2 minutes and 25 second intervals between each series vs. Placebo control.	Increased muscle strength in the group with sciatic lesion undergoing NM.	B1

NM – Neural Mobilization; GNM – Group submitted to Neural Mobilization; GSS – Group submitted to Static Stretching; CG – Control Group; MAGOG – Group which performed Medium Nerve Mobilization; GOG – Group which did not undergo Neural Mobilization; G1 – Group submitted to Neural Mobilization; G2 - Group submitted to Stretching (placebo); Qualis – Classification attributed by coordination of higher education in area 21 (physical education, physiotherapy, occupational therapy and speech therapy).

**Figure 1.** Flow chart of screening and selection of studies.



women, other study<sup>(11)</sup> evaluated only men and the last study,<sup>(12)</sup> patients both genres. In three articles,<sup>(11,13,14)</sup> the volunteers were considered healthy, irregularly active and neurologically asymptomatic and only two articles had their sample composed by individuals with leprosy<sup>(12)</sup> and rats with sciatic neuropathy.<sup>(15)</sup>

The evaluation protocol for muscle strength also varied among the studies, and four studies<sup>(11,12,14,15)</sup> including the experimental animal study, utilized electromyographic and only two<sup>(13,14)</sup> utilized hand grip dynamometer, as one of them being associated with electromyographic analysis. Regarding the intervention protocol, all studies used as an intervention the neural mobilization technique<sup>(11-15)</sup>, however, the duration of the treatment session ranged between one and ten minutes. Another important aspect is that only one article reported interval.<sup>(15)</sup> Regarding the interventions, only two studies conducted more than one session<sup>(12,15)</sup>, the authors used treatment protocols with 18 and 10 sessions. The first,<sup>(12)</sup> 3 times per week with 3 sets of 20 oscillations per minute, totaling 3 minutes. The second<sup>(15)</sup> 10 sessions, 5 times per week and with 5 sets of 2 minutes. Another interesting point is the nerves which were selected for technical application, these ranged between lumbosacral<sup>12</sup>, femoral nerve<sup>11</sup>, median<sup>(13,14)</sup>, radial ulnar<sup>(14)</sup> and sciatic nerves.<sup>(12,15)</sup>

The results varied among the studies, with three articles which evaluated the acute effects<sup>(11,13,14)</sup> and only two, the chronic effects.<sup>(12,15)</sup> Regarding the acute effects, Araujo et al.<sup>(14)</sup> did not observe any difference in manual pressure when comparing the NM group to placebo control group, intriguingly, Maciel et al.<sup>(13)</sup> despite not showing any increase in muscle strength, they observed an increase in the recruitment of muscle fibers and contraction time of the flexor muscles of the wrist and hand, finally, Lopes et al.<sup>(11)</sup> reported an increase in quadriceps muscle strength, evidenced by increased electrographic activity during isometric contraction. The last two studies involved populations with neuropathy. Thus, Santos et al.<sup>(15)</sup> evaluated rats submitted or not the sciatic neuropathy and observed a 50% reduction in the strength of injured animals, and surprisingly, in comparison with the injured group which did not subject to MN, it has achieved 172% increase in muscle strength. Finally, Vêras et al.<sup>(12)</sup> reported increase in the EMG signal and muscle strength, both referring to the tibialis muscles of patients with leprosy and weakness of the tibialis muscle.

## DISCUSSION

The results which were found in this systematic review point to the acute and chronic benefits of neural mobilization techniques on the muscular strength of different evaluated populations. In this regard, the selected references indicated that acutely the technique promoted responses such as maintenance, significant increase in strength, as well as in

muscle endurance and recruitment of motor units.<sup>(11,13,14)</sup> During the longitudinal analysis, it was also observed, positive effects related to the increase in the EMG signal and muscle strength in patients with injury in peripheral nervous system.<sup>(12,15)</sup>

The results suggest a new possibility in improving of muscular strength which might be inserted in physical rehabilitation programs, sports and recreational practices. Therefore, the results discussed herein were evaluated neurologically asymptomatic subjects with peripheral neural tissue injury. Another interesting point is that the set of techniques is easy to apply and low cost, as well as stretching exercises already established in the scientific, clinical and sports community. However, although the subject is an exciting possibility, the literature on the subject is still limited, relatively unexplored subject, and, according to our survey, the first study was published in 2010.<sup>(11)</sup>

Thus, in relation to acute effects, Araújo et al.<sup>(14)</sup> stated that the NM is not effective to produce increase in hand grip strength in healthy volunteers, only being observed the maintenance of muscle strength after one minute of mobilizing the median, ulnar and radial nerves. Contrary to this observation, Maciel et al.<sup>(13)</sup> also evaluated healthy female subjects, observing increased strength and resistance recruitment of muscle fibers of wrist flexors and fingers, immediately after five minutes of median nerve mobilization. Similarly, Lopes et al.<sup>(11)</sup> evaluated male participants, which observed that one minute session of femoral nerve mobilization was enough to increase the quadriceps muscle strength in neurologically asymptomatic individuals. The divergences in which were found in the results, may arise from some points such as the lack of standardization between NM protocols, in which there were differences in mobilized nerves and application time of the technique. The second point refers to protocol for muscle strength evaluation, in which a grip digital dynamometer, load cell attached to the manual grip dynamometer and electromyography, were used. Those three methodologies allow different observations, and electromyography is more sensitive to variations in muscle strength, which would justify the results of 4 studies in total of 5.<sup>(11,12,13,15)</sup>

Regarding the chronic effects, Vêras et al.<sup>(12)</sup> when evaluating individuals with lesion of the peripheral nervous system resulting from leprosy, they found that only neural mobilization group of the lumbosacral, sciatic and peroneal nerves, obtained statistical improvement of the evaluated parameters, which were linked to increased EMG signal and tibialis muscles strength. Interestingly, in a similar analysis performed by Santos et al.<sup>(15)</sup>, which underwent rats with sciatic nerve injury to a 10 sessions protocol with sciatic nerve mobilization, they observed that the treated animals showed improvement NM functionality and muscular strength measured by electromyography. The similarity of these results highlight to the fact that in both cases, the subjects had



peripheral neuropathy, and in the first case, even compared to conventional physical therapy, a neural mobilization program was more effective to promote beneficial results. This may be because the technique is directed to the nerve tissue,<sup>(5)</sup> which does not seem to be adequately stimulated by traditional therapies of physical rehabilitation.

Although the results are positive, some points need to be highlighted. 1) The evaluation of interventions in adult participants may not adequately represent young and old individuals; 2) although all studies were controlled, only one clinical study performed a sample adequacy calculation, which can lead to statistical bias as rejection or acceptance of hypotheses without actually being proved; 3) the lack of standardization of the technique allows the protocols to float and can not be compared; 4) to analyze the results based only on statistical precepts, limits the clinical inferences and thus the applicability of the results in clinical practice; 5) the follow-up period of the protocols may not have been sufficient to promote responses in a clinical point of view, and studies with better methodological rigor are required; and 6) the descriptors referring to neural mobilization and their synonyms have low sensitivity and specificity, limiting the searches in the electronic databases.

Although the mentioned aspects need further discussion, they do not impair the results presented, in which require further clinical investigation and scientific deepening. Since, it is an approach which aims the improvement of one of the main variables studied worldwide and with great representation in the scientific and sports community and physical and functional rehabilitation centers.

## CONCLUSION

The results indicate positive effects of neural mobilization techniques on electromyographic signal augmentation, muscle fibers recruitment, maintenance of peak strength of wrist and fingers flexor muscles, increase in quadriceps and tibialis muscle strength, and soleus muscle of rats submitted to injury of the sciatic nerve.

## AUTHOR'S CONTRIBUTIONS

Conception and design: Santos ACN, Petto J e Oliveira SS; Data collection: Santos ACN e Oliveira SS; Analysis and data interpretation and writing of the manuscript: Santos ACN, Oliveira SS, Tenório MCC, Petto J e Sá CKC; Critical review of the manuscript regarding the important intellectual content: Santos ACN, Petto J, Tenório MCC e Sá CKC.

## CONFLICTS OF INTEREST

None.

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