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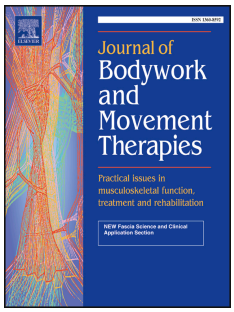

Neural gliding versus neural tensioning: effects on heat and cold thresholds, pain thresholds and hand grip strength in asymptomatic individuals

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Title: Neural gliding versus neural tensioning: effects on heat and cold thresholds, pain thresholds and hand grip strength in asymptomatic individuals

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Neural gliding versus neural tensioning: effects on extreme temperature thresholds, pain thresholds, and hand grip strength in asymptomatic individuals

Abstract

INTRODUCTION: Neural mobilization can be performed in a way that facilitates movement through a stretching technique (tensioning) or in a way that maximizes the gliding of peripheral nerves in relation to adjacent structures (gliding). Evidence on how these techniques compare in terms of effects are scarce. The aim of this study is to compare the effects of neural gliding and neural tensioning targeting the median nerve on heat and cold temperature threshold, heat pain threshold, pressure pain thresholds and hand grip strength in asymptomatic participants.

METHODS: Participants received 4 series of 10 repetitions of either neural gliding (n=30) or neural tensioning (n=30) and were assessed for heat and cold temperature threshold, heat pain threshold, pressure pain threshold and hand grip strength at baseline, immediately after the intervention, and 30 minutes post-intervention.

RESULTS: A significant main interaction between time and intervention was found for the PPT at the forearm ($F(2,55)=5.98$; $p=0.004$), favouring the tensioning neural mobilization. No significant differences were found for the other variables.

CONCLUSIONS: Four series of 10 repetitions of neural tensioning targeting the median nerve in asymptomatic subjects seem to be enough to induce hypoalgesia and have no negative effects on a-delta and c mediated sensory function and on hand grip strength production.

KEY WORDS: Sensory Threshold - Pain Threshold - Hand Strength – Median Nerve

Introduction

Nerves adapt to body movement and to the forces imposed to them through a variety of mechanisms while maintaining their normal functioning. They glide in relation to adjacent structures by means of a mechanism named excursion; the internal fascicules slide against each other (Rempel & Dahlin 1999); they elongate increasing internal strain, and they tolerate compression from adjacent structures (Topp & Boyd 2006). However, these normal mechanisms of nerves to adapt to day-to-day postures and movement seem to be compromised in certain pathologies, such as carpal tunnel syndrome, diabetes, cervicobrachialgia or epicondylitis (Beneciuk et al 2009).

Neural mobilization is a physical therapy technique that aims to restore the normal biomechanics of the peripheral nervous structures in order to restore its function (Butler 2000). In broad terms, it can be used in a way that maximizes nerve elongation (tensioning technique) or in a way that maximizes nerve excursion in relation to adjacent structures (gliding technique) (Butler 2000). The first consists of performing joint movements that elongate the nerve until symptoms appear, and then mobilize using the articular joint distal to where symptoms are believed originate. The second consists of using at least two joints performing movement simultaneously in a way that while one movement elongates the nervous structure, the other shortens it. It is believed that tensioning techniques increase nerve strain more than gliding techniques, while gliding techniques increase nerve excursion more than tensioning techniques without the potentially large increases in nerve strain (Coppieters et al 2015) and, therefore, it is thought that the probability of increasing patients' symptoms is higher when using neural tensioning.

A number of systematic reviews on the effectiveness of neural mobilization have recently been published and, in general terms, all conclude that neural mobilization is effective in nerve-related chronic pain (Efstathiou et al 2015; Su & Lim 2016; Basson *et* al 2017; Neto et al 2017). Potential mechanisms of action include: increased

intraneural fluid dispersion; (Gilbert et al 2015) increased expression of endogenous opioids in the periaqueductal gray; (Santos et al 2014) changes in the viscoelastic properties of nerves; (Andrade et al 2018) reduced concentration of inflammatory mediators involved in nerve pain; (Santos et al 2012) and, decreased adhesions (Oh et al 2006). Tensioning and gliding seem to result in different nerve excursions and internal nerve stresses and may involve a different number of joints moving simultaneously (Silva et al 2014), which can impact neurophysiological mechanisms differently. For example, increased nerve elongation, more likely in tensioning techniques, has been shown to have a potentially deleterious effect on median nerve function in individuals with carpal tunnel sýndrome (Ginanneschi et al 2015). In contrast, neural gliding is believed to promote nerve excursion while minimizing nerve elongation and strain (Coppieters & Alshami 2007). Existing studies comparing both techniques seem to suggest that the comparative effects of gliding and tensioning may depend on the variable being studied. Gliding has been shown to have a wider hypoalgesic effect than tensioning (Beltran-Alacreu et al 2015) and both techniques have been shown to have similar effects on hamstring flexibility (Sharma et al 2016). To our knowledge, no study has compared the effect of neural gliding and neural tensioning on heat and cold thresholds, important indicators of the function of C and A-delta fibers, which are commonly affected in peripheral neuropathies (Chéliout-Héraut et al 2005) or on muscle strength, which has a neural component. Therefore, the aim of this study was to compare the effects of neural gliding and neural tensioning targeting the median nerve on heat and cold temperature threshold, heat pain threshold, pressure pain thresholds and hand grip strength in asymptomatic participants. We used asymptomatic participants i) because neural mobilization has a potential role in prevention and on performance; ii) to avoid differences in mechanosensitivity that could be present in patients; and iii) because it permits the investigation of a potentially negative effect of neural mobilization on the function of the nervous system.

Methods

Design and ethics

This is a randomized, parallel and double-blind study, which was approved by the Service of Ethics and Bioethics, University of Aveiro. Before entering the study, participants were asked to sign a written informed consent.

Participants' inclusion and exclusion criteria and group allocation

Participants were asymptomatic individuals that were invited to join the study by the main investigator personally and through email and Facebook. To be included in the present study, participants had to be 18 years or older, naïve to neural mobilization and report no symptoms related to musculoskeletal pathology. In addition, participants were excluded if they reported any neurologic, cardiorespiratory, rheumatic or cancer pathology. Inclusion and exclusion criteria were ascertained by self-report; more specifically, each participant was given a written list of pathologies with the indication that if at least one of the listed pathologies applied to them, then they should not enter the study. Any doubts were clarified by the researcher that was present. The list of pathologies was accompanied by a list of signs and symptoms associated with each pathology.

An *a priori* sample size calculation was performed using G*Power and considering a moderate effect size (0.5), an alpha of 5%, power at 80% and that statistical analysis would be performed using a multivariate analysis of variance (within-between interaction). These calculations resulted in a total of 24 participants in each group and we decided to recruit 30 participants to account for potential losses.

The randomization of participants to group was performed by a researcher not involved in participants' recruitment, assessment or treatment using the software Randomizer

(www.randomizer.org) to generate a random sequence of numbers 1 (gliding) and 2 (tension). Information on which treatment each participant would receive was conveyed to the researcher performing the intervention immediately before it.

Procedures

Participants in both groups were assessed at baseline (T0), immediately after the intervention (T1) and 30 minutes post intervention (T2). At T0 each participant was assessed for: demographic data; anthropometric data; pain catastrophizing; fear of movement; anxiety; heat and cold threshold; heat pain threshold; pressure pain threshold; and, hand grip strength. Assessment procedures were applied in the same order at all time points to standardize the assessment and are described in detail in the following sections. Assessment was performed by researchers that were blind to participants' group allocation.

Demographic and anthropometric data

Demographics were assessed by a questionnaire purposely developed for this study. Weight and height were measured using a stadiometer-balance.

Pain catastrophizing, fear of movement and anxiety

Pain catastrophizing was assessed using the Pain Catastrophizing Scale (PCS), which is composed of 13 statements grouped into 3 subscales: rumination (4 items), magnification (3 items) and helplessness (6 items) answered on 5-point scales with the end points (0) not at all and (4) all the time. It has demonstrated good internal consistency (Cronbach α =0.91) (Jácome & Cruz 2004).

State and trait anxiety were assessed with the State-Trait Anxiety Inventory (Silva & Campos 1998), which has two subscales (state and trait), each measured using a 20-item scale. Scores range from 20 to 80 for each scale and higher scores are associated with higher levels of anxiety. It has demonstrated good internal consistency.

Fear of movement was assessed with the 13 item Portuguese version of the Tampa scale, which showed good test retest reliability (ICC= 0.99). Total score ranges from 13 to 52 and higher scores indicate higher fear and insecurity for movement (Cordeiro et al 2013). These variables were assessed as they have been found to be associated with pain thresholds (Schmitz et al 2013; Thibodeau et al 2013).

Heat and cold threshold and heat pain threshold

These were measured using a QSense (Medoc Ltd) with a thermode of 30x30 mm and the method of limits both at the right thenar region and at the proximal third of the right ventral forearm. The cutaneous innervation as well as the innervation of most muscles in the thenar region is from the median nerve. The cutaneous innervation of the anterior part of the forearm is from the lateral and medial cutaneous nerves of the forearm (Gosling et al 2002). Both the lateral and medial cutaneous nerves cross the elbow anteriorly (Gosling et al 2002) and are likely to be affected by the neural intervention used. Participants were seated with the thermode attached to the thenar region/ anterior forearm and supported on a table. They were applied 4 heat stimuli of increasing temperature separated by 20 s of rest till they first feel heat. Then they were asked to press the command that they had in their left hand. We adopted similar procedures for cold threshold and pain threshold. For cold threshold the temperature decreased until participants first felt cold and for heat pain the temperature increased until participants first felt pain. The mean of the 4 measurements for each variable was

used in the analysis. Thermal quantitative sensory testing has been found to be reliable (Moloney et al 2011). Each measurement was first demonstrated on the left side.

Pressure pain threshold (PPT)

An algometer (JTECH Medical Industries) was used to measure PPT at both the thenar eminence and the proximal third of the right ventral forearm. As previously reported, the cutaneous innervation of the anterior part of the forearm is from the lateral and medial cutaneous nerves of the forearm, but the muscles underneath (wrist flexors and pronator teres are innervated by the median nerve (Gosling et al 2002). Before measurements on these points were taken, PPT measurement was demonstrated in the opposite upper limb to familiarize the patient with the procedure. Participants were instructed to say “stop” when the sensation changed from pressure to pain. The PPT was measured with the patient with the hand and forearm in supination and supported on a table. Three measurements were taken at each point. The mean value was used for between groups comparisons. A 30-second resting period was allowed between each measurement. A probe of 0.5 cm of diameter was used to reduce the analgesia effects (Ylinen et al 2007). The pressure was applied at a rate of 3N/s up to a maximum of 60N, which was not exceeded because of the risk of tissue damage.

Hand grip strength

This was assessed using a Jamar® hydraulic dynamometer (Lafayette Instrument Company, USA). Measurement procedures were in line with the American Society of Hand Therapy (Roberts et al 2011). Participants were seated in a chair with back support and arm support. The shoulder was in a neutral position and adducted; the elbow was at 90º flexion and the wrist at 30º extension. Participants were asked to

perform maximal grip strength with the dynamometer in a self-selected handle position (usually position two) for 6 seconds. Measurements were repeated 3 times for the right hand, with 1-minute interval and the mean of the 3 measurements was used for statistical analysis. The hand grip strength test is reliable (ICC between 0.85 and 0.98) (Peolsson et al 2001).

The investigator taking the PPT measurements was blind to the study group (i.e. did not know what treatment participants received).

Intervention

One group received neural gliding mobilization and the other neural tensioning mobilization, both targeting the median nerve. Initial participant positioning for gliding was: lying in supine, shoulder at approximately 90º of abduction, wrist in neutral, elbow at 90º flexion and head/neck neutral. From this starting position, participants actively and simultaneously performed extension of the elbow (to -45º) and ipsilateral neck flexion (to approximately 45º) and then returned to 90º of elbow flexion and 45º of contralateral neck flexion (Figure 1) while maintaining the shoulder at 90º abduction. According to Silva et al. (Silva et al 2014) this combination of movements was the one that promoted the greatest excursion of the median nerve (10.2mm) (Silva et al 2014).

Tensioning was performed with the subject lying supine. The investigator performed the upper limb neurodynamic test as reported by Butler (1989): shoulder depression; 110º of shoulder abduction; external shoulder rotation; wrist and fingers extension; forearm supination and then elbow extension. The final test position was defined as either i) end of joint amplitude or ii) the joint amplitude that provokes pain, paresthesia or numbness. In this case, a decrease of 5º to 10º of range of motion (elbow extension) was allowed for symptoms to disappear and from this end

position the investigator performed repetitive movements of approximately 10º of elbow flexion/extension while maintaining the test end position for all the other joints.

Please insert Figure 1 here.

For both gliding and tensioning, four series of 10 movements at a rhythm of approximately 6 seconds per cycle and one-minute rest between series was performed. Participants were not given information on which neural mobilization technique they were receiving; they were only told that they could receive one of two different neural mobilization techniques.

Data Analysis

All data analyses were performed using SPSS 24.0 for Windows (SPSS Inc, Chicago, IL). Mean and standard deviation, count and proportion were used to describe continuous and categorical variables, respectively. Data was assessed for outliers, normality and homogeneity of variance. Between group differences for baseline characteristics were explored using a Student's t test (continuous variables) or a Chi-square (categorical variables). A general linear model of repeated measures using time (T0, T1 and T2) and intervention (gliding vs. tensioning) as the factors was used to compare the effects of the interventions. Gender and state anxiety were included as covariates as number of males and females differed between groups and state anxiety was significantly different between groups at baseline. Post hoc comparisons

(Bonferroni) were used when a significant main effect was found for time. A significant level was set at $p<0.05$.

Results

Sample characteristics

A total of 60 participants, with 30 allocated to each group, entered the study. There were 16 males and 14 females in the tensioning group and 10 males and 20 females in the gliding group. No significant between group differences were found at baseline except for state anxiety ($p=0.029$), which was higher in the gliding group (Table 1).

Please insert Table 1 here

Intervention outcomes

No between group differences were found at baseline for thermal variables, PPT and hand grip strength ($p>0.05$).

No significant main effect of time and no significant interaction between time and intervention were found for hand grip strength, heat and cold threshold, heat pain threshold, pain intensity during heat pain threshold at any of the two measurement sites and for PPT when measured at the thenar eminence. Nevertheless, for heat threshold the interaction between time and intervention approached significance ($F(2,55)=3.08$; $p=0.07$). In addition, a significant main interaction between time and

intervention was found for the PPT at the forearm ($F(2,55)=5.98$; $p=0.004$). A significantly higher increase in PPT was found for the tensioning group (post intervention minus baseline = 5.25 Kgf; 30 minutes post intervention minus baseline = 4.12 Kgf) than for the gliding group (post intervention minus baseline = 1.86 Kgf; 30 minutes post intervention minus baseline = 1.55 Kgf). Pairwise comparisons revealed a significant difference between T0 and T1 ($p<0.001$) and between T0 and T2 ($p=0.037$). Please see Table 2 for detailed data.

Please insert Table 2 here

Discussion

Four series of 10 repetitions of neural gliding or neural tensioning seem to have had no positive or negative effect on hand grip strength, heat and cold threshold and heat pain threshold. Nevertheless, four series of 10 repetitions of neural tensioning seem to promote hypoalgesia at the forearm when compared to neural gliding in asymptomatic participants.

Studies comparing the effects of neural gliding and neural tensioning are scarce. This may conceivably be due to the fact that neural gliding is a much more recent technique than neural tensioning (Coppieters & Alshami, 2007). Beltran-Alacreu and colleagues (2015) compared the effects of neural gliding and neural tensioning in asymptomatic participants on PPT measured at the craniofacial junction, the neck and the tibialis and compared them against a placebo. Both groups received 7 minutes of each intervention. Mobilization was performed using the neck, the thoracic spine, the knee and the ankle. A statistically significant increase in PPT with both interventions was

reported for PPT at the neck and tibialis and at the craniofacial region for neural gliding only, with mean differences post-intervention between 2 and 7 Kg/cm^2. Nevertheless, the neural gliding and neural tensioning techniques were not identical in terms of the joints and movements used and the neural gliding technique seemed to have elicited more movement at the craniocervical junction (as per the figures) than neural tensioning. This could have contributed to the differences found. Differences in the joints used to mobilize and a slightly higher dosage of neural mobilization make a direct comparison with the results of the present study difficult but might suggest that a more global technique and higher dosage of neural mobilization is required to produce wider hypoalgesic effects.

One could question whether the absence of significant differences for the other outcome measures assessed could be due to insufficient “dose” of neural mobilization. Interestingly, the recent systematic reviews reach no conclusion regarding the appropriate dose of nervous system mobilization (Efstathiou et al 2015; Su & Lim 2016; Basson et al 2017; Neto et al 2017). Furthermore, two of these reviews (Su & Lim 2016; Neto et al 2017) did report on the high variability of the neural mobilization parameters (e.g., type of neural mobilization, frequency, duration, number of repetitions), what made any conclusion regarding the appropriate dosage difficult. When analyzing the individual studies included in the systematic reviews one can found studies reporting 3 series of 10 mobilizations, 2 series of 20 mobilizations or 5 stretching’s of 30 seconds each. Dosage is likely to be a key determinant of the effect of neural mobilization and therefore, requires further investigation. Silva et al (2013) reported that 3 minutes of neural tensioning was sufficient to promote hypoalgesia in sciatic patients and, in contrast, 7 minutes of neural mobilization made symptoms worse.

The present study showed that 4 series of 10 tensioning but not gliding mobilizations targeting the median nerve were enough to induce hypoalgesia at the forearm, which

was maintained 30 minutes after the end of the intervention. It has been suggested that neural mobilization induces hypoalgesia through a centrally-mediated mechanism, by activating both the descending pain inhibitory pathway and endogenous opioid-mediated pain modulatory systems (Su & Lim, 2016). Tensioning is believed to increase nerve strain more than gliding while gliding promotes the excursion of the nerve against its bed (Silva et al 2014). Nerve gliding was thought to be preferable when nerve mechanosensitivity is increased as in painful conditions (Coppieters & Alshami 2007). Future studies should compare the hipoalgesic effects of both techniques in individuals with different painful conditions as well as investigate potential secondary effects.

The mean difference found for PPT post-intervention and at 30 minutes were higher than the minimal detectable difference (MDC) for PPT that has been reported at different body sites, which suggests that it is a true difference. For example, MDC values of 1.90 Kgf or less have been reported when PPT was measured at C3-C4, infraspinatus and tibialis in a mixed sample of participants with and without chronic neck pain (Jørgensen et al 2014). Similar results were reported in a mixed sample of individuals with and without acute neck pain (Walton et al 2011).

The absence of significant effects for variables other than the PPT also suggests that 4 series of either tensioning or gliding have no negative effects on the sensory function as mediated by the C and A-delta fibers and motor (strength production) function in asymptomatic and young subjects. These findings, in addition to the findings that neural mobilization has a positive effect on flexibility (Park et al 2014) and on dynamic and static postural control (Ferreira et al 2019), suggests that it could be a useful procedure to use with athletes.

Limitations

This study results need to be taken into account considering its limitations: participants were asymptomatic subjects and findings may not apply to patients with pain and pathology; the dose of mobilization was based on our previous experience as no recommendation exists and higher doses may be required for neural mobilization to impact other variables such as strength and sensory function.

Conclusion

Four series of 10 repetitions of neural tensioning targeting the median nerve in asymptomatic subjects seem to be enough to induce hypoalgesia and have no negative effects on A-delta and C mediated sensory function and on hand grip strength production.

Clinical relevance

- Four series of neural gliding of the median nerve may be used to promote hypoalgesia.
- Four series of neural gliding of the median nerve have no negative effects on sensory and motor function.

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Figure legend

Figure 1 – Beginning (A) and end (B) positions for gliding mobilization.

Table 1 – Sample caracteristics (mean±standard deviation).

	Tensioning group (n=30)	Gliding group (n=30)	p value
Age (years)	21.77±2.70	22.80±3.79	0.229
Weight (Kg)	66.67±14.32	64.09±10.94	0.436
Height (cm)	170.80±10.11	168.13±8.46	0.272
Pain Catastrophizing Scale (range: 0 - 52)	26.87±7.53	24.73±3.89	0.173
TAMPA scale (range: 13 – 52)	19.83±10.11	18.80±9.25	0.681
State anxiety (range: 20-80)	48.53±2.94	50.23±2.3	0.029
Trate anxiety(range: 20-80)	48.70±4.04	47.93±3.90	0.458

Table 2 – Mean and standard deviation for outcome measures at baseline, immediately post-intervention and at 30 minutes post-intervention.

	Baseline		Post-intervention		30 minutes post-intervention	
	Tension (n=30)	Gliding (n=30)	Tension (n=30)	Gliding (n=30)	Tension (n=30)	Gliding (n=30)
Hand grip strength (Kgf)	38.12±11.56	36.27±10.60	39.20±10.47	36.47±11.79	39. 11±10.13	37.07±11.96
Heat threshold (tenar region) (º)	35.03±2.05	35.79±3.39	35.68±1.97	36.44±3.83	35.63±1 .83	36.22±3.93
Heat threshold (forearm) (º)	34.3±1.38	35.16±1.96	35.26±1.55	36.58±3.03	35.85±2. 02	36.99±3.67
Cold threshold (tenar region) (º)	29.36±1.81	29.61±1.44	28.67±1.57	28.56±3.00	28.69±2 .08	28.17±3.26
Cold threshold (forearm) (º)	29.6±1.30	29.77±1.63	29.47±1.27	29.08±2.23	29.25±1. 39	28.71±2.38
Heat pain threshold tenar (º)	43.04±3.04	43.36±4.38	44.28±3.55	43.43±4.44	44.04±3 .59	43.83±4.09
VAS at tenar heat pain threshold (1 -10)	3.83±2.15	3.67±2.66	3.27±2.36	3.57±2.66	3.00±2.46	3 .53±2.67
Heat pain threshold forearm (º)	41.86±2.60	41.94±3.85	41.99±2.87	42.10±4.03	41.72±2 .52	42.93±3.99
VAS at forearm heat pain threshold (1-10)	3.30±1.76	3.60±2.51	3.23±2.01	3.43±2.37	3.03±2.20	3 .53±2.78
PPT (thenar region) (Kgf)	42.35±15.8	46.38±14.54	46.22±15.72	47.89±13.50	45.4 7±15.40	47.84±13.69
PPT (forearm) (Kgf)	34.75±14.41	39.11±14.54	40.0±13.77	40.97±14.25	38.87±14.45	40.66±14.99

VAS – 1º cm visual analogue scale.