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# Short term effectiveness of neural sliders and neural tensioners as an adjunct to static stretching of hamstrings on knee extension angle in healthy individuals: A randomized controlled trial

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ABSTRACT

*Objective:* To investigate the added benefit of nerve-biased interventions over static stretching in hamstring flexibility and to compare the effectiveness of two types of nerve-biased interventions over a week.
*Design:* Three-arm assessor-blinded randomized controlled trial.
*Setting:* University Laboratory.
*Participants:* Sixty healthy individuals (mean age = 22 ± 2.4 years) with reduced hamstring flexibility were randomized to three groups who received static stretching and neurodynamic sliders (NS-SS); static stretching with neurodynamic tensioner (NT-SS) and static stretching (SS) alone.
*Outcome measure:* Knee extension angle (KEA) in degrees.
*Results:* Baseline characteristics including demographic, anthropomorphic and KEA between groups were comparable. A significant interaction was observed between group (intervention) and time, [$F_{(2,114)} = 3.595$; $p = 0.031$]. Post-hoc pairwise comparisons analyses revealed significant differences at post-intervention measurement time point between NS-SS and SS (mean difference: −6.8; 95% CI = −12, −1.5; $p = 0.011$) and NT-SS and SS (mean difference: −11.6; 95%CI = −16.7, −6.3; $p < 0.001$). However there was no significant difference between NS-SS and NT-SS groups (mean difference: 4.8; 95% CI = 0.4, 9.9; $p = 0.074$).
*Conclusions:* Neural sliders and tensioners are both effective in increasing hamstring flexibility as an adjunct to static hamstring stretching when compared to static stretching alone. No neural mobilization technique proved to be superior over another.
Clinical trial registration: This clinical trial is registered in Clinical Trials Registry- India (CTRI) with registration number CTRI/2012/05/002619.

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## 1. Introduction

Optimal muscular flexibility and joint range of motion (ROM) are necessary for optimal physical (strength, endurance and fitness) and psychosocial wellbeing (Law et al., 2009). Any alterations in muscular flexibility could directly influence the function of other joints in the kinetic chain. Reduction in joint ROM can lead to altered mechanics and could result in joint dysfunction. Reduced hamstrings flexibility, due to reduced stretch tolerance (Law et al., 2009), is one common clinical presentation that has frequently been associated with musculoskeletal disorders such as low back pain (Tafazzoli & Lamontagne, 1996), sacroiliac joint dysfunction (Arab et al., 2009), hamstring injuries (Heiderscheit et al., 2010; Henderson et al., 2010; Witvrouw et al., 2003), patellofemoral pain syndrome (Petersen et al., 2013), patellar tendinopathy (van der Worp et al., 2011) and plantar fasciitis (Bolivar et al., 2013; Labovitz et al., 2011).

Various factors such as the viscoelastic properties of muscle (Magnusson et al., 1996), stretch tolerance (LaRoche and Connolly, 2006; Magnusson, 1998) and neurodynamics (Ellis et al., 2012)

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can contribute to hamstring flexibility. Physiological adaptations of these factors (Cipriani et al., 2012) can potentially result in restricted ROM of knee extension. Additionally, the hamstrings act as a mechanical interface surrounding the sciatic nerve. Nerve adhesions in the hamstring may alter neurodynamics and cause abnormal mechanosensitivity of the sciatic nerve; which could influence hamstring flexibility. Changes in mechanosensitivity of the neural tissue have been shown to limit hamstring length in normal healthy individuals (Lew and Briggs, 1997; McHugh et al., 2012) and in individuals with previous hamstring injuries (Kornberg & Lew, 1989; Turl and George, 1998). Any mechanical or physiological alterations in the nerve can result in mechanosensitivity which is the sensitivity of a nerve to movement (Boyd et al., 2009) and can contribute to pain during movement or sustained postures (Shacklock, 2005).

Abnormal mechanosensitivity can potentially be addressed by the performance of neurodynamic sliders (NS) and neurodynamic tensioners (NT) (Butler, 1991; Shacklock, 2005) which produce excursion and tension of the neural tissues, respectively (Coppieters et al., 2009; Ellis et al., 2012). If unaddressed, abnormal mechanosensitivity of the sciatic nerve may predispose an individual to recurrent episodes of hamstring injury (Kornberg & Lew, 1989). Different interventions used to increase hamstring flexibility have been investigated (Castellote-Caballero et al., 2013; Davis et al., 2005; Decoster et al., 2005; Fasen et al., 2009; Mendez-Sanchez et al., 2010; O'Hora et al. 2011; Puentedura et al., 2011; Schuback, Hooper, & Salisbury, 2004; Webright et al., 1997; Youdas et al., 2010). One technique used to improve hamstring flexibility is static stretching (Decoster et al., 2005) which improves the visco-elastic properties and stretch tolerance of the muscle (Magnusson et al., 1996; Magnusson, 1998). Neural contribution to hamstring flexibility has been studied in the past (Castellote-Caballero et al., 2013; Fasen et al., 2009; Kornberg & Lew, 1989; Mendez-Sanchez et al., 2010). However the effects of neural sliders and neural tensioners on hamstring flexibility have not been directly compared. Also, most of the previous studies have methodological flaws including the use of inappropriate outcome measures including the measurement of straight leg raise (SLR) using a universal goniometer (Castellote-Caballero et al., 2013; Mendez-Sanchez et al., 2010). During SLR contralateral hip flexor length and increased pelvic rotation can confound the results (Davis et al., 2008). Another study (Fasen et al., 2009) measured knee extension without controlling hip position which could also have impacted the results. To our knowledge, only one study has considered both static stretching of hamstrings and neurodynamic slider in combination on a small sample ($n = 8$) (Mendez-Sanchez et al., 2010). To date both types of mobilization techniques (NS and NT) have not been compared in a single clinical trial. Also, previous studies rarely measured hamstring flexibility with a reference standard outcome measure i.e. knee extension angle (KEA) (Davis et al., 2008).

Therefore the aim of the current study was to investigate the added benefit of two types of neural tissue mobilisation techniques (NS and NT) as an adjunct intervention to static stretching as compared to an active control group (SS alone) on hamstring flexibility as measured by KEA.

## 2. Methodology

### 2.1. Study design

The design of this study was a three-armed randomized, controlled trial (RCT). Ethical Clearance was obtained from the Institutional Ethics Committee (IEC 41/2012), Manipal University, India. The study was registered in Clinical Trials Registry- India (registration number CTRI/2012/05/002619).

### 2.2. Participant recruitment

Healthy University students who volunteered to participate in the study were screened for inclusion criteria between December 2011 and March 2013. Individuals with reduced hamstring flexibility, measured as knee extension angle (KEA) $\geq 20°$ (Covert et al., 2010) were eligible to participate. As part of the screening process, KEA was measured for both lower extremities. If KEA were unequal, the side where KEA was greater was used as the experimental side. When both sides had the same KEA value, the dominant side was used. Dominance was determined as in previous studies (Chan et al., 2001; O'Hora et al., 2011) as the preferred side to kick a ball. Participants with a history of any illness, spine and lower extremity surgeries, current hamstring strain or injury, current low back pain or leg pain, or who were already involved in other flexibility programmes were excluded.

### 2.3. Group allocation, randomization and blinding

Random number sequence was generated using www.random.org. Block randomization (Moher et al., 2010) was performed in order to ensure that each group had equal number of participants. Five blocks of 12 participants in each block were prepared prior to the start of the study by a research expert who was not involved in the study. Every block ensured four participants from each group at the completion of a block. Sequentially numbered, opaque, sealed and stapled envelopes were used for the allocation concealment. Baseline measurements were taken after the group allocation by the assessor who was blind to group allocation. The participant handed over the envelope to the treating therapist. Participants in group-1 (NS-SS) received NS after static stretching of hamstring musculature; group-2 (NT-SS) participants received NT after static stretching; whereas group-3 (SS) participants received only static stretching.

### 2.4. Intervention

To provide safe and effective neural mobilization, interventions for all groups were provided by the primary investigator who underwent formal training in clinical neurodynamics from Neurodynamic Solutions and Neuro Orthopedic Institute, Australasia. Three sessions (Day-1; Day-4 and Day-7) of intervention were provided for all participants. For all the groups, a single *Static Stretching (SS)* of hamstring musculature with a 30 second hold was provided by the physical therapist with the participants in supine with the hip and knee in 90–90 degrees of flexion and the foot in plantar flexion as the starting position (Fig. 1). To provide the stretch, the knee was slowly extended until maximum resistance was felt by the physical therapist with the ankle in plantar flexion. The physical therapist made sure that the stretch did not cause any pain. This form of static hamstring stretching in 90-90 with the foot plantar flexed was chosen to minimize the tensioning on the sciatic and the tibial nerves. All participants irrespective of the groups were taught a single 30 second hold of hamstring static stretch (hip flexion with extended knee held passively against a wall) with the aim of maintaining improvement in hamstring flexibility. This stretching was to be carried out once every day outside the experimental setting. This dosage of stretching was chosen because 30 seconds of static hamstring stretch is as good as stretching for 60 seconds but better than stretching for 15 seconds in increasing hamstring length. Also, stretching once and three times has shown to not result in any difference on hamstring length (Bandy and Irion, 1994; Bandy et al., 1997). To ensure compliance with the exercise, participants were asked to maintain a home exercise log

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