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Manual Therapy 11 (2006) 130–135
MANUAL THERAPY
www.elsevier.com/locate/math

Original article

Mulligan bent leg raise technique—a preliminary randomized trial of immediate effects after a single intervention

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Received 20 May 2004; received in revised form 1 April 2005; accepted 27 April 2005

Abstract

The aim of this study was to investigate the effects over 24 h, on range of motion and pain, of a single intervention of Mulligan's bent leg raise (BLR) technique in subjects with limited straight leg raise (SLR) and low back pain (LBP). Mulligan techniques are frequently used in practice but their effectiveness has not been adequately researched. Ninety-four subjects were contacted by telephone and 46 volunteered for assessment. Of these, 24 fulfilled inclusion criteria of unilateral SLR limitation and LBP. All subjects were naïve to physiotherapy, blinded, and randomly allocated to either a BLR ($n = 12$) or placebo group ($n = 12$). Range of SLR was measured by an assessor blind to group allocation, prior to, immediately following, and 24 h after the intervention. Similarly pain was assessed prior to, and 24 h after the intervention. After adjusting for differences in baseline values of SLR range, there was no difference between the two groups immediately after the intervention. However, 24 h later, there was a significant increase in the range by 7° in the BLR group, which may be clinically important. In addition there was a one-point reduction in pain, but no difference between groups. This preliminary study provides limited support for the use of the BLR technique; however, further research is required.

Keywords: Low back pain; Manual therapy; Straight leg raise; Mulligan

1. Introduction

Mulligan (1999) manual therapy treatment techniques are frequently used in clinical practice. Konstantinou et al. (2002), reported that in Britain, according to a postal survey, 41% of physiotherapists treated low back pain (LBP) using Mulligan techniques. In spite of its popularity, the efficacy of the Mulligan Concept has not been adequately established by clinical trials.

The Mulligan bent leg raise (BLR) technique has been described as a means of improving range of straight leg raise (SLR) in subjects with LBP and/or referred thigh pain (Mulligan, 1999). The intention of this technique is to restore normal mobility and reduce LBP and physical impairment. Impairment is defined as abnormalities of structure or function, as indicated by signs or symptoms (American Physical Therapy Association, 2001). Several authors have stated that in general terms the link between pain and impairment is weak (Strong, 2002; Waddell, 1998). In contrast, the SLR test is one impairment which has been linked to LBP (Deville et al., 2000; Deyo et al., 1992; Grieve, 1970; Meszaros et al., 2000). However, according to others, this test has poor correlation with respect to disability (Hazard et al., 1994; Nattrass et al., 1999).

It has been suggested that improving SLR mobility reduces the degree of impairment in LBP (Blunt et al., 1997; Hall et al., 2001; Hanten and Chandler, 1994). Unfortunately, there is no research evidence to support these conjectures. In addition, it has become increasingly recognized, that although mobilization has a place to play in the management of LBP (Bronfort et al.,

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1356-689X/$ - see front matter © 2005 Elsevier Ltd. All rights reserved.
doi:10.1016/j.math.2005.04.009

2004), there is disagreement as to how it should be used (Koes et al., 2001). Hence physiotherapists use a range of different approaches to manage LBP (Gracey et al., 2002).

Physiotherapists routinely reassess patients immediately post-treatment. This information guides treatment selection and predicts possible longer-term outcomes (Hahne et al., 2004). The SLR test is a useful measure, in this regard, because immediate effects of treatment can be determined. In contrast, other forms of assessment, such as functional disability questionnaires, are difficult to be used in this context.

The SLR test has biomechanical effects on pelvis movement, on lumbosacral neural structures (Breig and Troup, 1979; Butler, 1991) and hamstring muscles (Burns and Mierau, 1997). Hence, it is important when investigating SLR to evaluate the component movements that include hip flexion and posterior pelvic rotation (Hall et al., 2001).

The aim of this study was to investigate the immediate effect of a single intervention of the Mulligan BLR technique on pain and range of movement in subjects with LBP.

2. Methods

This small-scale prospective, explanatory, double-blind, randomized placebo-controlled trial compared the immediate effects of the BLR technique to a placebo. Curtin University Human Research Ethics Committee gave ethical approval for the study. All data collection was carried out at this facility.

Hypotheses were that the BLR technique would improve range of SLR and reduce pain, greater than a placebo and that any change in range would be maintained 24 h later.

2.1. Subjects

Ninety-four participants volunteered for the study, following local community advertising. In effect this group were self-selected. Fig. 1 demonstrates the flow chart for subject entry and subsequent passage through the study. All subjects were contacted by telephone and those with LBP and/or thigh pain (Mulligan, 1999) were invited to be physically assessed for inclusion in the study.

Subsequently participants were included if they had a unilateral limitation of SLR more than 15°. Exclusion criteria were the presence of clinical features of lower quarter neurological compromise (Hall and Elvey, 2004). Twenty-four subjects were identified as fitting the entry criteria and provided informed consent.

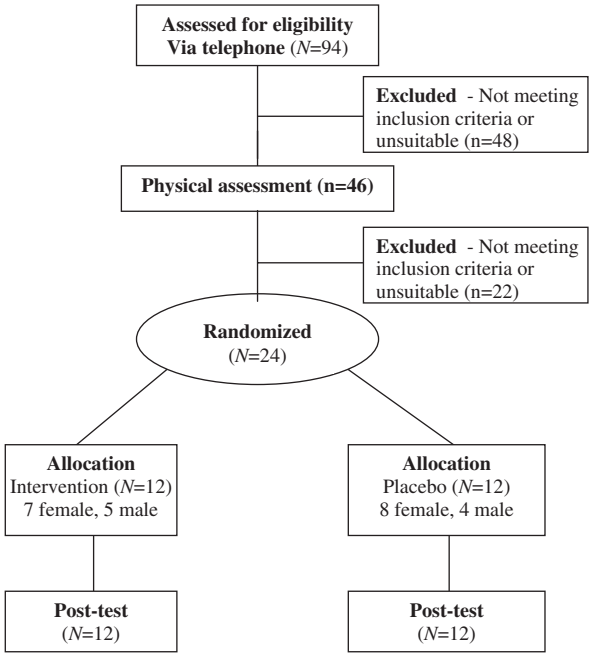

Fig. 1. Flow diagram demonstrating progress of participants through the study.

2.2. Variables

Independent variables were treatment (BLR, placebo) and time (pre, post, follow-up). Dependent variables were range of SLR, pelvic rotation and hip flexion at the onset of pain as well as average pain intensity over 24 h.

Range of SLR and pelvic rotation were measured by two bubble inclinometers (Chattanooga Group Baseline, Hixson, TN 37343, USA), with an accuracy of 1°. Range of hip flexion was calculated by subtracting pelvic rotation from SLR. Pain was measured using a 10 cm visual analogue scale (VAS) (Scott and Huskisson, 1979).

2.3. Procedures and randomization

Subjects were randomly assigned to either BLR or placebo group, by lottery ticket picked at random from a concealed container.

Two examiners, blinded to group allocation, performed all measurements. The participants were asked to lie with one leg on each side of a vertical board. A modified ankle foot orthosis (AFO) was used to maintain the ankle in neutral plantargrade, while a rigid knee extension brace was used to maintain the knee in full extension (Fig. 2).

Range of SLR and pelvic-rotation were recorded, before, immediately after and 24 h following the treatment. The subject was asked to indicate their average level of pain 24 h prior to and 24 h following the intervention.

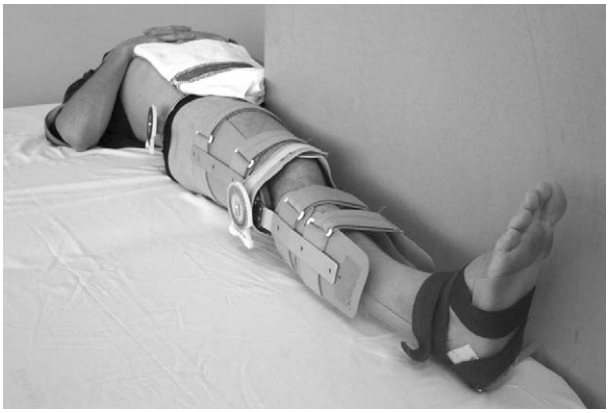

Fig. 2. Measuremant apparatus.

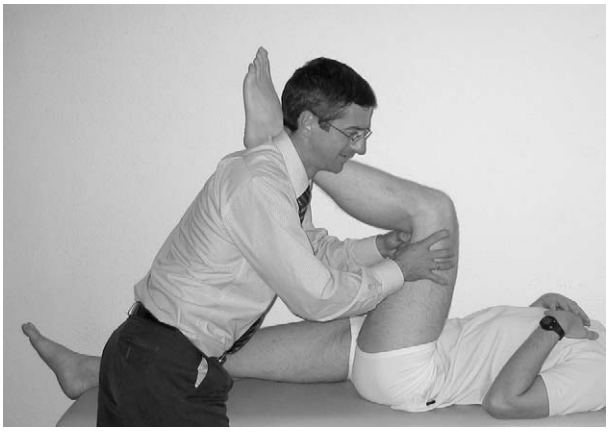

Fig. 3. Mulligan BLR technique.

After measuring ROM, the two investigators left the room and a third investigator carried out the randomization process. This investigator, trained in the use of Mulligan techniques by an accredited Mulligan Concept teacher, carried out the assigned intervention before the first two investigators returned for subsequent re-measurement.

The BLR technique (Mulligan, 1999) consisted of three repetitions of pain-free, 5 s, isometric contraction of the hamstrings, performed in five progressively greater positions of hip flexion (Fig. 3). The placebo consisted of soft tissue manipulation of the foot, with the knee flexed to 20°.

At the completion of the investigation subjects were asked if they thought they were in the BLR or placebo group, in order to assess the efficacy of the blinding. Six of 12 participants in the placebo group and seven of 12 in the BLR group believed to have had received the "real" treatment. Therefore, we concluded that the blinding of the participants was successful.

2.4. Statistical analysis

All statistical testing was carried out using the Statistical Package for Social Science version 11.0 software. Differences were considered statistically significant at $p<0.05$. An analysis of variance was used to determine the effect of treatment on pain and range of SLR immediately after the intervention and after 24 h follow-up, after adjusting for unbalanced baseline values. To ensure that the assumptions of the analysis of variance were satisfied, the residuals from each analysis were assessed for normality using the Kolmogorov–Smirnov and the Shapiro–Wilk tests. In addition, homogeneity of variances' were tested using Levene's test.

An intra-tester reliability assessment was performed on the first 10 participants. Measurement of SLR and pelvic rotation were recorded, all equipment removed, re-applied, and further measures taken. Intraclass Correlation Coefficients (ICC) for SLR was 0.99 (SD 1.2, SEM .12, 95% confidence interval 0.96–0.99) and for pelvic rotation was 0.98 (SD 8.9, SEM 1.3, 95% confidence interval 0.92–0.99).

3. Results

The BLR group contained 12 subjects (mean age 41 ± 16 years, VAS score $3/10\pm2$) and the placebo group 12 subjects (mean age 48 ± 13 years, VAS score $3/10\pm2$). Although the mean ages were statistically different, the small difference was not deemed clinically relevant.

The descriptive statistics for raw measurements of SLR, pelvic rotation and hip flexion are shown in Table 1.

Table 1 shows that there was a large difference, between the groups, at baseline assessment, for mean range of SLR and subsequently hip flexion and pelvic rotation. When accounting for this baseline difference, the results indicate, that the BLR technique did not have a significant effect on range of SLR ($p=0.24$), immediately after treatment. The adjusted means are shown in Table 2. The difference between these adjusted means was only 3°. A power calculation was carried out to determine the sample size required to detect a significant difference between the two groups at this point ($\alpha=.05$, power $=0.8$). A minimum of 20 subjects in each group is recommended.

In contrast, again after adjustment, the results 24 h after intervention indicate that the BLR technique had a significant effect on range of SLR (f value $=5.87$; $p=0.025$). The adjusted means are shown in Table 2. The adjusted mean difference between the two groups, at this point, was 7°, the standard error of mean was 3°

Table 1
Descriptive statistics for unadjusted range of SLR, pelvic rotation and hip flexion

Group	SLR° (SEM)			Hip flexion° (SEM)			Pelvic rotation° (SEM)		
	Pre	Post	24 h	Pre	Post	24 h	Pre	Post	24 h
BLR	34(5)	45(3)	47(3)	26(2)	33(2)	35(2)	9(4)	12(2)	12(3)
Placebo	49(4)	54(4)	54(4)	38(1)	42(2)	41(2)	11(3)	12(4)	12(3)

Key: SEM—standard error mean.

Table 2
Adjusted means for SLR immediately following the intervention

Group	Mean SLR° (SEM, 95% confidence interval)	
	Immediately after intervention	24 h after intervention
BLR	51 (1.8, 48–55)	54 (1.9, 50–58)
Placebo	48 (1.8, 44–52)	47 (1.9, 43–51)

Key: SEM—standard error mean.

and the 95% confidence interval for the difference was 1–13°.

The residuals from both the above analysis were normally distributed and the assumption of homogeneity of variance was satisfied.

3.1. Pain outcome

In both groups the VAS pain scores significantly reduced by $\frac{1}{10}$ following the intervention (f value = 7.71, $p < .01$). However, the BLR technique was no more effective than the placebo (f value = 0.205, $p < 0.65$).

3.2. Pelvic rotation and hip flexion

We wanted to know the proportion of hip flexion and pelvis rotation influencing the SLR range in the BLR group. From the unadjusted data, we calculated the improvement of SLR is 70% due to hip flexion and 30% due to pelvic rotation.

4. Discussion

Baseline values for range of SLR were different between the two groups. Presumably due to the small sample size and randomization. After adjusting for these differences, this study demonstrated a significant difference of 7° in range of SLR, 24 h following the intervention, between the BLR and placebo group. However, the difference was only 3° immediately after the intervention. Dixon and Keating (2000) suggest that improvement in range of SLR must be greater than 6° to state that a real change in SLR range has occurred. Consequently, the change in range produced by the BLR group is of clinical relevance only 24 h after the intervention. Some caution is advised when interpreting these results, as the sample size was small and self-selected so the external validity is questionable.

A number of studies have investigated techniques to improve range of SLR in asymptomatic samples (Clark et al., 1999; Hall et al., 2001; Sullivan et al., 1992; Worrell et al., 1994). The improvement in range determined in these studies ranged from 8° to 13°. Only two other studies, known to us, have investigated the effect of treatment interventions on SLR range in subjects with LBP (Beyerlein et al., 2002; Meszaros et al., 2000). Improvement in SLR range was 11° (Beyerlein et al., 2002) and 8° (Meszaros et al., 2000). However, these studies did not incorporate a placebo or control group.

It is uncertain why, in our study, improvement in range of SLR was effective 24 h after but not immediately after the intervention (after accounting for differences in baseline measures). No previous studies have investigated the BLR technique, but other Mulligan techniques designed to improve range of SLR show immediate improvements after the intervention (Beyerlein et al., 2002; Hall et al., 2001). Again, one explanation may be the small sample size and unequal range of SLR prior to the intervention.

This study found that a placebo technique increased range of SLR. This gain is unlikely to be due to repeated application of SLR as previous studies have shown a limited conditioning effect of only 1° per trial with repeated measures of SLR (Taylor et al., 1990). As the placebo was not aimed at structures that could have a mechanical effect on SLR range, we assume that this improvement was a true placebo effect. The placebo response is known to be associated with conditioning and expectancy, involving activation of the limbic system and triggering analgesic centres (Wall, 1994). It is inevitable, like all manual therapy, that the BLR technique will also have a placebo response. However, 24 h after the intervention, there was a difference of 7° SLR, between the two groups. This indicates that the true effect of the BLR technique was 7°, which is of clinically significant importance.

Both the BLR and the placebo significantly reduced pain after the intervention, but there was no difference between groups, and the improvement was only one on the VAS. Farrar, 2000 state that a pain reduction of 50% is considered to be a clinically significant outcome of a treatment programme, a reduction not achieved in the present study as only a single episode of treatment was given. In addition both groups had very low baseline pain levels, with an average of $\frac{3}{10}$ on the VAS. Clinically significant pain reduction is not to be expected when pain is at a relatively low level to begin with (Rowbotham, 2001). The small sample size probably also contributes to this result. A larger sample size, undergoing a complete treatment programme, would be required to determine any benefit the BLR technique might have on pain.

Improvement of SLR range, by the BLR technique, might be due to mobilization of the painful, sensitized, nerve tissues, similar to the "slider" effects described by Butler (1991) and Elvey and Hall (1997). However, it is unlikely that this is the main treatment benefit; in a comparable LBP sample with SLR limitation, only one-third of the subjects had signs of sensitized neural tissue (Beyerlein et al., 2002).

Another beneficial effect of the BLR technique might be a change in stretch tolerance of the hamstrings. Goeken and Hof (1994) demonstrated that the increased range of SLR, following stretching, is mediated via an increase in hip flexion and hamstring length, and not related to increased hamstring viscoelastic properties. This is consistent with the findings from the present study, where 70% of the improvement in range was due to a change in hip flexion. In addition, Harvey et al. (2003) found no increase in hamstring extensibility after 4 weeks of hamstring muscle stretching in patients with spinal cord injuries. It seems reasonable to extrapolate that increase in hamstring extensibility is closely connected to central neurophysiological processing, which is severely impaired in patients with spinal cord injuries. Thus it might be assumed that the BLR technique triggers neurophysiological responses influencing the muscle stretch tolerance. This is supported by the fact that in the present study there was a trend towards increased posterior pelvic rotation. An increase in hamstring extensibility might reduce stress on painful lumbar tissues and hence allow an increase in posterior pelvic rotation resulting in greater lumbar flexion.

There are several limitations of this study including the small sample size, which may be the reason for the difference in mean range SLR prior to the intervention. In addition, the randomization process was not concealed from the therapist applying the intervention.

Overall, these results indicate that the BLR technique provides limited benefit in the treatment of patients with LBP where there is limitation of SLR. We investigated the effect of only one single treatment session; the effect size may be greater if the BLR technique is integrated in a whole treatment regimen, including exercise to maintain the treatment effect, as is current clinical practice.

5. Conclusion

This study provided preliminary evidence that a single intervention of Mulligan's BLR technique, resulted in improvement in range of SLR 24 h later but not immediately after the intervention. Pain also improved, but this technique was no better than a placebo. A larger study is required to verify these findings.

References

American Physical Therapy Association. Guide to Physical Therapy practice. 2nd ed. Physical Therapy 2001; 81(1): 746

Beyerlein C, Hall TM, Hansson U, Odemark M, Sainsbury D, Lim HT. Effektivität der Mulligan-straight-leg-raise-Traktionstechnik auf die Beweglichkeit bei Patienten mit Rückenschmerzen. Manuelle Therapie 2002;6:61–8.

Blunt KL, Rajwani MH, Guerriero RC. The effectiveness of chiropractic management of fibromyalgia patients: a pilot study. Journal of Manipulative and Physiological Therapeutics 1997;20(6):389–98.

Breig A, Troup JDG. Biomechanical considerations in the straight-leg-raising test. Cadaveric and clinical studies of the effects of medial hip rotation. Spine 1979;4(3):242–50.

Bronfort G, Haas M, Evans RL, Bouter LM. Efficacy of spinal manipulation and mobilization for low back pain and neck pain: a systematic review and best evidence synthesis. Spine 2004;4(3):335–56.

Burns SH, Mierau DR. Chiropractic management of low back pain. In: Singer KP, editor. Clinical anatomy and management of low back pain. Oxford: Butterworth-Heinemann; 1997. p. 344–57.

Butler DS. Clinical neurobiomechanics. In: Mobilisation of the nervous system. Melbourne: Churchill Livingstone; 1991. p. 35–54.

Clark S, Christiansen A, Hellman DF, Hugunin JW, Hurst KM. Effects of ipsilateral anterior thigh soft tissue stretching on passive unilateral straight-leg raise. Journal of Orthopaedic and Sports Physical Therapy 1999;29(1):4–9.

Deville WLJM, van der Windt DAWM, Dzaferagic A, Bezemer PD, Bouter LM. The test of Lasegue. Spine 2000;25(9):1140–7.

Deyo RA, Rainville J, Kent DL. What can history and physical examination tell us about low back pain? The Journal of the American Medical Association 1992;268(6):760–70.

Dixon JK, Keating JL. Variability in straight leg raise measurements: review. Physiotherapy 2000;86(7):361–70.

Elvey RL, Hall TM. Neural tissue evaluation and treatment. In: Donatelli R, editor. Physical therapy of the shoulder 3rd. New York; PA: Churchill Livingstone; 1997. p. 131–52.

Farrar JT. What is clinically meaningful: outcome measures in pain clinical trials. Clinical Journal of Pain 2000;16(2 Suppl):S106–112.

Goeken LN, Hof AL. Instrumental straight-leg raising: results in patients. Archives of Physical Medicine and Rehabilitation 1994;75(4):470–7.

Gracey JH, McDonough SM, Baxter GD. Physiotherapy management of low back pain: a survey of current practice in Northern Ireland. Spine 2002;27(4):406–11.

Grieve GP. Sciatica and the straight-leg-raising test in manipulative treatment. Physiotherapy 1970;56:337–46.

Hahne AJ, Denehy L, Pretto J. Do within-session changes in pain intensity and range of motion predict between-session changes in patients low back pain. Australian Journal of Physiotherapy 2004;50(1):17–24.

Hall TM, Elvey RL. Management of mechanosensitivity of the nervous system in spinal pain syndromes. In: Boyling G, Jull G, editors. Grieves Modern Manual Therapy 3rd. Churchill Livingstone; 2004. p. 413–31.

Hall TM, Cacho A, McNee C, Riches J, Walsh J. Effects of Mulligan traction straight leg raise on range of movement. The Journal of Manual and Manipulative Therapy 2001;9:128–33.

Hanten WP, Chandler S. Effects of myofascial release leg pull and sagittall plane isometric contract-relax technique on passive straight leg-raise angle. Journal of Orthopaedic and Sports Physical Therapy 1994;20:138–44.

Harvey LA, Byak AJ, Ostrovskaya M, Glinsky J, Katte L, Herbert RD. Randomised trial of the effects of four weeks of daily stretch on extensibility of hamstring muscles in people with spinal cord injuries. Australian Journal of Physiotherapy 2003;49(3):176–81.

Hazard RG, Haugh LD, Green PA, Jones PL. Chronic low back pain: the relationship between patient satisfaction and pain, impairment, and disability outcomes. Spine 1994;19(8):881–7.

Koes BW, van Tulder MW, Ostelo R, Kim Burton A, Waddell G. Clinical guidelines for the management of low back pain in primary care: an international comparison. Spine 2001;26(22):2504–13.

Konstantinou K, Foster N, Rushton A, Baxter D. The use and reported effects of mobilization with movement techniques in low back pain management: a cross-sectional descriptive survey of physiotherapists in Britain. Manual Therapy 2002;7(4):206–14.

Meszaros TF, Olson R, Kulig C, Creighton D, Czarnecki E. Effect of 10%, 30% and 60% body weight traction on the straight leg raise test of symptomatic patients with low back pain. Journal of Orthopadic and Sports Physical Therapy 2000;30(10):595–601.

Mulligan BR. Other spinal therapies. In: Manual therapy: ''nags'', ''snags'', ''mwms'' etc. 4th. Wellington: Plane View Services; 1999. p. 68–86.

Nattrass CL, Nitschke JE, Disler PB, Chou MJ, Ooi KT. Lumbar spine range of motion as a measure of physical and functional impairment: an investigation of validity. Clinical Rehabilitation 1999;13(3):211–8.

Rowbotham M. What is a 'clinically meaningful' reduction in pain? Pain 2001;94:131–2.

Scott J, Huskisson EC. Vertical or horizontal visual analogue scales. Annals of Rheumatic Diseases 1979;38:560.

Strong J. Chronic pain problems. In: Strong J, Unruh A, Wright A, Baxter DG, editors. Pain: a textbook for therapists. Edinburgh: Churchill Livingstone; 2002. p. 397–410.

Sullivan MK, Dejulia JJ, Worrell TW. Effect of pelvic position and stretching method on hamstring muscle flexibility. Medical Science and Sports Exercise 1992;24(12):1383–9.

Taylor D, Dalton J, Seaber A, Garrett W. Viscoelastic properties of muscle-tendon units: the biomechanical effects of stretching. American Journal of Sports Medicine 1990;18:300–9.

Waddell G. The physical basis of back pain. In: The back pain revolution. Edinburgh: Churchill Livingstone; 1998. p. 135–54.

Wall PD. The placebo and placebo response. In: Wall PD, Melzack R, editors. The textbook of pain 3rd. Edinburgh; New York: Churchill Livingstone; 1994. p. 1297–307.

Worrell TW, Smith TL, Winegardner J. Effect of hamstring stretching on hamstring muscle performance. Journal of Orthopaedic and Sports Physical Therapy 1994;20(3):154–9.