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Effects of occipito-frontal release with dorsiflexion technique (OFRDF) for improvement of superficial back line flexibility

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ABSTRACT

Background: Hamstrings tightness is a major risk factor concerning lower back pain and lower extremity injuries. Occipito-frontal release with dorsiflexion technique is a novel technique developed to improve the superficial back line (SBL) flexibility. This technique combines passive and active loading at the cephalic end, and caudal end of the SBL, respectively.

Objectives: To compare the effects of OFRDF and passive static stretching aimed at improving SBL flexibility in sedentary participants.

Materials and methods: Fifty-six participants demonstrating bilateral hamstring tightness (passive knee extension angle test greater than 20 degrees) were recruited. Participants were allocated via stratified block randomization (block size 4 and 6). Participants in the experimental group partook in OFRDF technique, whereas participants in the control group partook in passive static stretching. Both groups performed each intervention 3 times a week. Outcome measures were passive knee extension angle (PKE), craniovertebral angle (CVA), and sit and reach (SR) distance. Outcomes were measured at baseline, after the primary intervention, and post third intervention. A mixed-model ANOVA was used to compare mean difference within both the OFRDF and control groups and to compare between groups..

Results: A 3 (time) x 2 (group) mixed-model ANOVA demonstrated that both techniques shown to significantly decrease PKE angle on both sides, increase CVA and SR when compared between the third and initial intervention. However, all outcomes exhibited non-significant differences when compared between groups.

Conclusion: OFRDF and passive static stretching of the hamstrings can both similarly improve SBL flexibility.

Introduction

Hamstring muscle tightness is a key risk factor in regard to lower back pain.[1-3] This condition increases inappropriate posterior pelvic tilting. Flat-back is consequently induced abnormal stress and strain on lumbar structures.[4] In addition, hamstring muscle tightness is associated with various musculoskeletal disorders, such as lower extremity injuries[5], and walking and running inability.[6]

Passive static stretching is a popular method to improve hamstring flexibility among physical therapists. The unique characteristics of passive static stretching are that it exhibits a gentle style and is comfortable amid application.[7,8] Because hyperalgesia of hamstrings is an important symptom for consideration in some musculoskeletal conditions, passive static stretching is not a suitable method to treat acute hamstring strain or sciatica pain.[9] In these situations,

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direct technique to hypersensitive muscle should be avoid. Thus, this study paid attention to the indirect technique instead.

An important fundamental technique is Anatomy trains, as claimed by Myers. OFRDF was designed to apply force to the superficial back line (SBL) which is the meridian at the back of the human body.[10] Many strong evidences have incorporated both anatomic[11-13] and functional studies.[9,14-17] Moreover, the hamstring muscles is one component of the SBL which is located superiorly to the plantar fascia, achilles tendon, gastronomies muscles, and sacrotuberous ligament. Hamstrings are inferiorly positioned to the thoracolumbar fascia, erector spinae muscles, and occipito-frontalis muscles.[10] According to basic biomechanics, force application to the caudad and cephalad structures of serial connection may indirectly improve SBL component flexibility. This method was designed to passively force application to the occipito-frontalis muscle, and active force to the plantar fascia and gastronomies muscles.[17] Hence, for this particular study, SBL was selected as the target meridian. Previous study found that OFRDF can increase the SBL flexibility when comparing with rest.[10] Although, the immediate effect of OFRDF was revealed, the standard method should be compared to elucidate the effectiveness of technique.

This study chose to represent the SBL flexibility in three parts. Firstly, craniovertebral angle test (CVA) is used for measuring flexibility of the upper part of the SBL. In this study, we applied the 3-points marker detection program to assess CVA. This method demonstrated superior agreement between this method and goniometry.[18] SR was utilized in this study for flexibility measuring of the middle part of the SBL. Secondly, sit and reach test (SR) is used to assess middle part of the SBL for the reason that it is the general flexibility test which related to multiple body segments. In more detail, it also has the ability to reveal the lower back flexibility. Moreover, it is frequently applied amid studies involving the SBL.[9,16] Lastly, passive knee extension angle test (PKE) is the gold standard for represent hamstrings flexibility[19] which is the lower part of the SBL because PKE does not aggravate neural tension, 20 does not involve participants' quadriceps strength,[19,21] and incorporates less pelvic rotation.[19,21,22]

This study hypothesized that OFRDF and passive static stretching of hamstrings can increase the SBL flexibility similarly. Therefore, this study was carried out to compare effects of treatment technique between OFRDF and passive static stretching on SBL flexibility.

Materials and methods

Participants

Fifty-six participants with bilateral hamstring muscle tightness were recruited for testing. The sample size was calculated according to popliteal angle test (PA) in a 2015 study of Cho *et al.* who presented the effect of the suboccipital inhibition technique and self-myofascial release technique on hamstrings flexibility. The number of participants in their study was 50 (suboccipital inhibition group=25 and self-myofascial release group=25, s_1=7.1, s_2=6.5). Fifteen Significance level was lower than 0.05 ($Z_{\alpha/2}$ (0.025)=1.96) and power of test at 80% (Z_{β} (0.2)=0.84) were applied for calculation with 5% drop-out.[23] The screening of bilateral hamstrings tightness using passive knee extension angle test was performed by the assessor. The inclusion criteria consisted of male or female with bilateral hamstrings tightness (passive knee extension angle test greater than 20 degrees)[9,24] aged between 18 to 24 years, 1) BMI 18.5-24.9 kg/m^2, and 2) presenting a sedentary lifestyle including activities such as using a tablet or mobile phone, lying down, sleeping, sitting, watching television, and physical activity did not exceed 30 minutes/day, 3 days/week. The exclusion criteria consisted of participants with 1) spinal disorders (cervicogenic headache, neck pain, upper back pain, or lower back pain during the study period), 2) vertebrobasilar insufficiency, 3) regular stretching exercises (yoga or stretching exercises), 4) using muscle relaxants or nonsteroidal anti-inflammatory drugs (NSAIDs) 24 hrs prior to, and during the study period, 5) a history of whiplash injury, 6) presenting a history of fractures of the spine and/or lower extremities, 7) hamstring muscles tendinitis or muscle strain prior to the study, 8) hypermobility (Beighton score >4), 9) a severe orthopedic condition (scoliosis, kyphosis, flat-feet, high arch, or leg-length discrepancy), 10) a severe neurological condition (brain injury, spinal cord injury, nerve root compression, hyperalgesia, hypereflexia or hyperalgesia), and 11) those unable to perform the positioning required amid intervention or assessment.

The participants were randomized using a stratified block randomization technique (4 and 6 participants per block) and were stratified by gender, and degree of hamstring tightness (20 to 35 degrees, and 35 to 50 degrees).[24] The concealed envelop in each block was achieved using random numbers generated via the https://www.sealedenvelope.com/simple-randomiser/v1/lists. This study was approved by the Khon Kaen University Ethics Committee for Human Research (HE 622270), participants were recruited via advertisement. The assessor performed screening and physical examination amid the selecting of participants. Participants meeting inclusion criteria were invited to sign a participation consent form.

Procedures

This study was an assessor-blinded randomized controlled trial conducted at the School of Physical Therapy, Faculty of Associated Medical Sciences, Khon Kaen university, Thailand. Participants were informed about scope and study details. They were then allocated into two groups. Participants in the experimental group partook in OFRDF technique, whereas participants in the control group engaged in passive static stretching. Both groups performed their respective exercises amid each intervention for 3 days within a one-week period.[19] The physical therapist who performed OFRDF differed from the physical therapist who assessed outcome measurements. Notably, he boasted clinical experience of greater than 4 years in addition to a training period with a specialist over 10 hours. Furthermore, the assessor was a physical therapist with greater than 5 years of clinical experience. Subsequent to the training period (10 hours), the assessor performed intra-rater reliability of the passive knee extension angle test, the craniovertebral angle test, and the sit and reach test. The results of all tests were excellent (ICC=0.985-0.992). All outcome measurements were assessed throughout 4 P.M-7 P.M. She assessed outcome measurements prior to experimentation to establish baseline. Measurement recording was then conducted 5 mins after the initial intervention for immediate effect, and after the third intervention to compare repetitive effect. Participants rested between each outcome measurement for 2 mins.

Interventions

Occipito-frontal release with dorsiflexion (OFRDF) technique

A participant comfortably lies on his/her back. The physical therapist flexes and extends the participant's upper cervical spine utilizing passive shearing force via soft movement cyclic loading. During flexion, each participant bends his/her ankle joint by way of dorsiflexion. In addition, the participant bends his/her ankle joint by way of plantar flexion (Figure 1). With their hands the physical therapist ensures a uniform intensity of force throughout palpation of occipito-frontalis muscle tension and the anatomical barrier of occiput movement. Treatment cycle times were compared with metronome. OFRDF is performed throughout 5 mins incorporating 10 repetitions per set within 1 minute, totaling 3 sets and 1-minute rest between sets.[17]

(a) Starting position

(b) Occipito-frontal release with dorsiflexion technique (OFRDF)

***Figure 1**. Occipito-frontal release with dorsiflexion technique (OFRDF).*

Passive static stretching of hamstrings

A participant comfortably lies on his/her back. The physical therapist slowly flexes each participant's hip with knee extension from 0 degree as far as possible (not beyond 90 degrees). Determination of the end point of passive movement is a tight sensation without pain at the posterior thigh (Figure 2). The physical therapist should avoid combined movement of the hip joint. Direction of load application should be pure hip flexion without hip rotation. This technique is performed over a total time of 5 mins. In one set of stretching, the physical therapist performs this technique 30 seconds per time incorporating 3 repetitions per set. After each stretching occurrence, the participant rests for 20 seconds with the process repeated on the other side.[25–27]

(a) Starting position

(b) Passive static stretching of hamstring muscles

Figure 2*. Passive static stretching of hamstring muscles.*

Outcomes

Sequencing of outcome measurements were the passive knee extension angle test, the craniovertebral angle test, and the sit and reach test.

The passive knee extension angle test: PKE

A participant comfortably lays on his/her back and the assessor bends the participant's examined hip to 90 degrees of hip flexion. The assessor places an inclinometer at the most anterior portion of the tibial shaft utilizing straps. The contralateral limb is fixed in its full extension using a table and belt. After that, the assessor passively extends the participant's knee until they feel a strong yet tolerable stretch at the posterior thigh, with the assessor recording the angle. This test is performed three times with average score recorded.[21] (Figure 3)

The craniovertebral angle test: CVA

A participant stands in a relaxed position. The assessor then places markers on the spinous process of C7 and tragus of the selected ear side. The 3-point marker detection program is used to assess CVA. The digital camera is located 1 meter from the participant with the image taken once a participant performs spot marching five times. In this study 3-point marker detection is utilized with digital image processing to calculate real time angles between markers. This program begins with searching markers, and then automatically calculates distance between markers (Figure 4). Moreover, the program can transform selected variables to be a CVA base amid trigonometric function.[18]

(a) Starting position

(b) Passive knee extension angle test

Figure 3*. Passive knee extension angle test.*

(a) Starting position

(b) Craniovertebral angle test

Figure 4*. Craniovertebral angle test.*

The sit and reach test: SR

A participant sits on the floor with both knees extended with the feet flat against the measuring box. The assessor asks a participant to reach forward over the measuring box and hold that position for 2 seconds. This test is performed twice selecting the maximum flexibility value in centimeter.[9] (Figure 5)

(a) Starting position

(b) Sit and reach test

Figure 5. *Sit and reach test.*

Statistical analysis

Descriptive statistic was used to describe demographic participants' data. Mean and standard deviation (SD) were employed to describe both demographic data, and outcome value measurements. Kolmogorov-Smirnov was applied to test for normality of data. A mixed-model ANOVA was used to compare mean difference within both the OFRDF and control groups and to compare between groups. Significance level was set at $p<0.05$. In this study, we employed SPSS version 23.0 for Windows for data collection and data analysis.

Results

Demographic data, health status, and baseline characteristics

Sixty-eight participants were recruited and screened by the assessor throughout January 29 to February 19, 2020. Fifty-six eligible participants were subsequently included in the study; of the 12 participants excluded half were excluded due to lower back pain, with the remaining reporting hamstring muscles strain. Eligible participants had PKE tested on both sides to represent bilateral hamstring muscles tightness. CVA and SR were also tested to establish baseline values as shown in Figure 6. The demographic data and baseline characteristics were shown in Table 1.

Mean and standard deviation of outcome measures in OFRDF, and the control groups were presented. Kolmogorov-Smirnov showed normal distribution of data ($p>0.05$). Therefore, a mixed-model ANOVA was used to compare mean difference within both the OFRDF and control groups and to compare between groups as seen in Table 2. The within subject effect and the between subject effect showed no interaction effect ($p>0.05$).

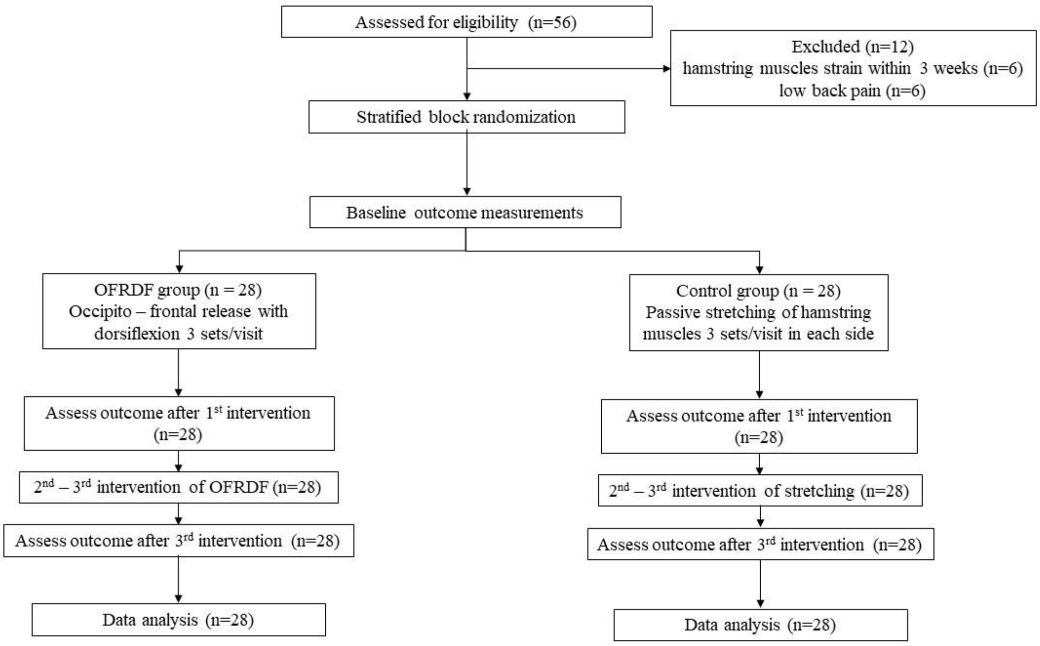

Figure 6. *Flow of participant procedures .*

Table 1 Demographic data and health status amid main study.

Baseline characteristics	Mean±SD	
	OFRDF	Control
Age (years)	20.75±1.8	20.93±1.68
Gender; n of male (%)	11 (39.29%)	13 (46.43%)
Weight (kg)	59.16±11.97	62.5±15.13
Height (centimeters)	164.79±7.83	167.04±8.56
Body mass index	22.93±0.87	23.33±1.34
Marital status (n)		
Single	28	28
Married	0	0
Divorced	0	0
Occupation (n)		
Student	23	26
Physical therapist	4	2
Teacher	1	0
Underlying diseases (a person exhibiting more than one underlying disease) (n)		
Non	27	22
Allergy	1	4
Asthma	0	1
G6PD	0	1
Gastritis	0	1
Exercise (n)		
Non	19	19
Once a week	4	3
Twice a week	3	3
3 times a week	2	3

Table 2 Comparison of the outcome measurements within the OFRDF and control groups, and between groups.

Outcome measurements	OFRDF			Control		
	Time interval			Time interval		
	1	2	3	1	2	3
Rt.PKE (degrees)	66.12±8.39	63.51±9.22	60.5±9.3*	62.71±7.92	58.41±9.85	57.75±11.63^
Lt.PKE (degrees)	68.64±8.73	66.12±9.63	62.99±9.96*	66.24±7.41	62.27±9.35	60.85±10.4*
CVA (degrees)	40.63±4.74	41.95±5	42.33±4.64*	40.13±5.53	41.24±4.75	42.3±5.42*
SR (centimeters)	-6.88±7.6	-5.17±8.02	-3±8.12*	-6.72±9.18	-4.02±9.25	-3.08±9.01*

*Rt.PKE=the passive knee extension angle test (right side), Lt.PKE: the passive knee extension angle test (left side), CVA: the craniovertebral angle test, SR: the sit and reach test, 1: baseline, 2: initial intervention, 3: third intervention, *Statistically significant differences between third intervention and baseline (p<0.05)*

Variables

A 3 (time)x2 (group) mixed-model ANOVA revealed a significant main effect for time, $F_{(2,100)}$=31.646, *p*<0.01, eta-squared=0.369. However, the main effect for group was not significant, $F_{1,54}$=2.435, *p*>0.05, eta-squared=0.043. Thus, there was no overall difference in the right passive knee extension angle of OFRDF compared with passive static stretching.

A time x group mixed-model ANOVA demonstrated a significant main effect for time, $F_{(2,92)}$=30.489, *p*<0.01, eta-squared=0.361. Although, the main effect for group was not significant, $F_{1,54}$=1.424, *p*>0.05, eta-squared=0.026. Therefore, there was no overall difference in the left passive knee extension angle of OFRDF compared with passive static stretching.

A mixed-model ANOVA showed a significant main effect for time, $F_{(2,98)}$=12.974, *p*<0.01, eta-squared=0.194. In contrast, the main effect for group was not significant, $F_{1,54}$=0.106, *p*>0.05, eta-squared=0.002. Hence, there was no overall difference in craniovertebral angle of OFRDF compared with passive static stretching.

A mixed ANOVA demonstrated a significant main effect for time, $F_{(2,99)}$=32.24, *p*<0.01, eta-squared=0.374. However, the main effect for group was not significant, $F_{1,54}$=0.035, *p*>0.05, eta-squared=0.01. Henceforth, there was no overall difference in sit and reach distance of OFRDF compared with passive static stretching.

Discussion

Our primary objective was to compare the effects of OFRDF and passive static stretching on SBL flexibility. According to the results, OFRDF and passive static stretching presented similar effects in terms of decreasing hamstring muscles tightness (lower part of the SBL), increasing sit and reach distance (middle part of the SBL), and increasing craniovertebral angle (upper part of the SBL). The results supported the hypothesis of the study that OFRDF and passive static stretching of hamstrings can increase the SBL flexibility similarly.

OFRDF is a novel technique combining passive as well as active myofascial release. Hence, it should be compared with standard interventions for the elucidation of the exact effects amid flexibility dimensions.[17] Passive static stretching was chosen as a comparative procedure to assess hamstring flexibility.[7,8,25–27] Although, passive static stretching can increase hamstring flexibility, it may cause injury in some conditions, such as in acute hamstring strain or sciatic pain.[9] The unique characteristic of the OFRDF method is a cyclic loading application which is employed to progressively stretch myofascial components in a pain-free movement. Importantly, OFRDF does not produce overstretching.[17] In the clinical field, OFRDF ought to be applied amid further study pertaining to musculoskeletal disorders incorporating lower back pain and hamstring tightness.

OFRDF and passive static stretching showed a significant decrease in knee extension degree in PKE on both sides as well as a significant increase in SR. These findings are supported by previous studies which utilized a different technique (suboccipital inhibition).[9,14,15,28] To clarify, suboccipital inhibition comprises of a passive myofascial release technique whereby the therapist applies passive tension and shearing forces on the suboccipital muscles. OFRDF observes a similar style, though participants actively bend their ankles upwards.[17]

According to thixotropic properties, cyclic loading and surface contact amid manual therapy may provide mutual heat generation[29] which increases heat and blood circulation in the selected muscles.[30] Alterations in tissue viscosity may increase tissue flexibility and ROM.[31]

OFRDF may enhance flexibility resultant of autogenic inhibition[31] and cyclic loading. Besides that, OFRDF may provide afferent feedback from the Golgi tendon organs (GTOs), at the myotendinous junction, and from the fascia to spinal cord. Because GTOs attach a series of muscle connections,[30] stimulation of GTOs via active ankle dorsiflexion[32] can decrease motor unit firing rate and normalize muscle tension.[33] Moreover, cyclic loading may also progressively increase strain on selected myofascial components.[17]

According to neuromechanical properties, OFRDF and nerve mobilization are similar in style, as both procedures utilize cyclic loading to indirectly move or stretch nervous tissue. The external passive force at the cervical region promotes nerve sliding in the vertebral canal. A previous study also suggested that nerve sliding in the vertebral canal can improve nerve mobility superiorly to localized stretching.[34] It is possible that free nerve movement may enhance the effectiveness of neuronal transduction to the muscles, bones, and joints. Thus, improvements in hamstring flexibility may be involved with the indirect effect from nerve to muscle.

In contrast, the control group engaged in passive static stretching. Findings supported the results of previous studies which employed SLR to stretch the hamstrings.[27,35] The mechanism of passive static stretching in increasing body flexibility is involved with autogenic inhibition, and thixotropic property as described prior.[31,36]

Interestingly, different techniques can demonstrate similar therapeutic effects; for example, OFRDF produced the immediate effect of significantly increasing CVA. According to a similar style presented by both techniques, the current result was supported by a study by Jeong and coworkers who applied the suboccipital inhibition technique.[28]

Passive static stretching of the hamstrings can increase CVA when comparing between the third intervention and baseline. This result was consistent with a study by Hyong and Kang who revealed that passive static stretching of the hamstring muscles can increase cervical range of motion.[37] These results may be explained by the force transmission of the SBL. Loosening the musculofascial component in one area may increase the flexibility of the same component in the distant area on the same meridian.[9,14–16,28,37,38]

In contrast, both PKE, CVA and SR were not statistically significantly different amid comparison between the third intervention and first interventions in both groups. The results may relate to participants' lifestyles due to the fact that we recruited participants exhibiting sedentary lifestyles. Accordingly, their activities involved mobile phone usage and prolonged posture. This sustained position may as a consequence, induce tightness of hamstrings and cervical extensor.

In consideration of the comparison in therapeutic effects between groups, there was a non-statistically significant decreasing degree of PKE amid both sides, an increasing CVA, and SR distance. These results corroborate with a study conducted by Krause and coworkers[39] who proved that local stretching of the cervical region or hamstring stretching can increase cervical ROM similarly. This result is supported by Anatomy Trains theory which claims the remote effect of the selected member amid the same meridian. In this study, passive static stretching of the hamstring muscles affected upper cervical extensor flexibility (craniovertebral angle). Stretching of the hamstrings –the SBL component- may alternate overall flexibility of the same meridian. Hence, force application on one component of the selected meridian may affect another component of the same meridian, which in turn leads to similar effects amid both techniques.

This study has some limitation points for consideration. Firstly, the markers for CVA assessments were placed on the cloth of participants according to the culture and may lead to inaccurate of the results. Secondly, we could not entirely control participants' activities of daily living. Due to diversity of activities, participants may perform other activities which disturb the therapeutic effects of treatment. For example, prolonged sitting or standing may activate muscle loading and disturb the body's flexibility. Thirdly, SR reflects non-specific bodily flexibility. Increased flexibility resultant of utilizing SR cannot solely produce SBL flexibility. In some cases, participants demonstrated shoulder-flexibility augmentation. Hence, subjects were able to easily perform the sit and reach test. Thus, body flexibility values are increased consequence of SR. Lastly, we included participants aged 18 to 24 years meaning it is difficult to extrapolate the results to other groups.

Conclusion

OFRDF and passive static stretching of the hamstrings can similarly improve the SBL flexibility. In case of hamstrings hyperalgesia, it is possible that a physical therapist can apply OFRDF to improve hamstrings flexibility in patients exhibiting hamstrings strain or sciatica pain for the prevention of unwanted adverse effects.

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