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A preliminary study of myofascial release technique effect on the range of hip flexion, knee flexion, and ankle dorsiflexion motion at affected lower extremity in individuals with chronic stroke

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ABSTRACT

Background: Muscle contractures lead to many problems (i.e., reduced joint range of motion (ROM) and decreased soft tissue extensibility) and may consequently lead to deformities and loss of function in individuals with chronic stroke. Myofascial release (MFR) technique has been recognized as a therapy option for improving the soft tissue extensibility and increasing joint ROM in other population. However, no study has investigated effects of the MFR technique on lower limb muscle flexibility in individuals with chronic stroke.

Objectives: This preliminary study aimed to investigate the effect of myofascial release (MFR) technique at the superficial back line on ROM of hip flexion, knee flexion, and ankle dorsiflexion changes in the affected side of lower extremity in individuals with chronic stroke.

Materials and methods: Fifteen individuals with chronic stroke who complained stiffness of the affected lower extremity while walking and met all inclusion criteria were enrolled in the study. The MFR technique was applied on the superficial back line (plantar fascia, achilles tendon, gastrocnemius muscle and hamstrings muscle) in the affected side of lower extremity, 10 minutes per area, 3 times per week for 4 weeks (12 times) by a physical therapist. ROM of hip flexion, knee flexion and ankle dorsiflexion were measured at pre-intervention, immediate-intervention, and 4 weeks after intervention using a goniometer by a blinded assessor. One-way repeated measure analysis of variance was used to compute data.

Results: The ROM of hip flexion, knee flexion, and ankle dorsiflexion were significantly greater at immediate-intervention and 4 weeks after intervention as compared to baseline ($p<0.05$).

Conclusion: This preliminary study summarized that the MFR technique could increase ROM of hip flexion, knee flexion and ankle dorsiflexion in the affected side of lower extremity in individuals with chronic stroke. The MFR technique may be used as an alternative option combined with general training program for stroke rehabilitation.

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Introduction

Sensory and motor impairments, including weakness for voluntary movement, spasticity, and poor coordination are causes of long term disability in individuals with stroke.[1] The sensorimotor impairments contribute to further impairments including increased pain, increased muscle tone, decreased range of motion, and shortened muscle length, which lead to reduced function in individuals with chronic stroke.[2, 3] Immobilized muscle in a shortened position causes negative altering in a muscular structure, known as muscle contractures (such as "spastic myopathy").[4] The muscle contractures are characterized by decreased muscle fiber length, shortened muscle connective tissue, and increased muscle stiffness.[5] These altered structures affect reductions of joint range of motion (ROM) and soft tissue extensibility, leading to deformities and loss of function (e.g., walking, standing and activity of daily living).[3, 4] Various Physical Therapy techniques used to improve soft tissue contracture in individuals with chronic stroke includes hot pack, ultrasound, neuromuscular electrical stimulation, stretching, mobilization, and myofascial release technique (MFR).[6] A previous systematic review by Wilke et al.[7] has suggested that myofascial release (MFR) technique at superficial back line (plantar fascia, achilles tendon, gastrocnemius muscle and hamstrings muscle) increases muscle flexibility. This technique might improve muscle properties, function ability and activity in daily living in patients with chronic stroke due to myofascial chain change.

The MFR technique is a manual technique of soft tissue releasing and muscle stretching to maintain muscle length, decrease pain, and increase muscle flexibility, soft tissue flexibility, and joint ROM.[6, 8] This technique requires an external force used for decreasing fibrous tissue adhesive in the muscles, low load, and long duration used to stretch the myofascial complex in order to restore an optimal length, resulting in decreased pain and improved function.[9] The MFR has been reported that it has beneficial effect on dilatating skin capillary and changing skin temperature.[10] Moreover, there are some changes in joint biomechanics and increase in muscle flexibility,[10] and decrease in fascial adhesion.[11]

Accumulating evidence have investigated an effect of MFR technique in various populations. A previous study investigating effect of self MFR at hamstrings muscle using a foam roller found significant increase in joint ROM and muscle flexibility but not in a muscle power in athletes.[12] Silva et al.[13] investigated an acute effect of MFR in individuals with total knee arthroplasty and reported a significant increase of knee flexion. A pilot study by Park and Hwang[14] showed a beneficial effect of MFR with a tennis ball on improving in balance performance in patients with chronic stroke who had a spastic on lower extremity muscle flexibility. However, an evidence demonstrating an effect of MFR technique in individuals with chronic stroke on increasing joint ROM and muscle flexibility on lower extremity due to soft tissue contracture is scarce. Therefore, this preliminary study aimed to determine effect of MFR technique at superficial back line on ROM of hip flexion, knee flexion, and ankle dorsiflexion at the affected lower extremity in individuals with chronic stroke.

Materials and methods

Participants

Fifteen individuals with chronic stroke who complained stiffness (difficulty in moving leg up to clear the floor during walking) in the affected lower extremity while walking was enrolled in this study.

Inclusion criteria consisted of (a) a diagnosis of infarction or hemorrhage stroke more than 6 months post-onset, (b) a Modified Ashworth Score (MAS) greater than 1 of affected lower extremity, (c) independent to walk with or without an assistive device, (d) no orthopedic problems at the lower extremities that would affect gait such as total knee or total hip arthroplasty in affected side, fracture in affected lower extremity. Exclusion criteria were (a) a stroke more than one hemisphere, (b) the repeated stroke, (c) a flaccid tone of lower extremity muscle, (d) premorbid problems that would affect patterns.

Sample size was estimated from a pilot study using a ROM of hip flexion (mean±SD). With 80% power, 5% type I error, a sample size of 12 was required to detect a difference between pre- and post-intervention. To allow 20% drop out, a total sample size of 15 was required for this study.

Participants who agreed to participate in this study were asked to sign informed consent before conducting the study. Ethical approval number 431/2019 for the study was granted by the Faculty of Associated Medical Science, Chiang Mai University, Thailand.

Measurements

ROMs of hip flexion, knee flexion, and ankle dorsiflexion in each participant were measured using goniometer by a blinded assessor. Degree of passive and active movements of all three actions was assessed during supine lying position. On each action, a maximum value among three trials was recorded. ROMs were measured before, immediate (immediately at the first end) and 4 weeks after (immediately at the last end) intervention. The assessor was assessed test-retest reliability before study. Degrees of passive and active movements of the hip flexion, knee flexion, and ankle dorsiflexion in five individuals with chronic stroke were measured. The test-retest reliability was calculated using by ICC model (3, 1).

Hip flexion

Fulcrum of goniometer was placed on a greater trochanter of a femur bone, stationary arm was positioned along lateral line of body, and moveable arm was placed on the side of the femur bone toward lateral epicondyle of the femur bone. For passive movement performed at the affected side, an assessor moved the knee to chest until the end of movement or limit by pain. For active movement, participants were instructed to perform action same as the passive movement with their backs straight.[15] In this study, the test-retest reliability was 0.98 in passive and active movement.

Knee flexion

Fulcrum of goniometer was placed on lateral epicondyle of femur, stationary arm was paralleled to the femur bone pointed to greater trochanter, and moveable arm was paralleled to the fibular bone pointed to the lateral malleolus. For passive movement of knee flexion, assistance slipped foot of the participants on the bed towards buttock until the end of movement or limit by pain. For active movement of knee flexion, the participants were commanded to perform action same as the passive movement.[16] The test-retest reliability of passive and active movements were 0.95 and 0.99, respectively.

Ankle dorsiflexion

To measure the ROM of ankle dorsiflexion, fulcrum of goniometer was placed on the lateral malleolus, stationary arm was put along the fibular bone, and moveable arm was paralleled the alignment of the fifth metatarsal bone. For measurement of passive movement, plantar of the affected side of each participant was moved up, in which the calf muscle was not too much stretched for preventing reflex from the ankle joint. The participants were then commanded to move their plantar in the affected side up for measuring an active movement. During the active movement, knee flexion during moving plantar up should be warned.[17] The test-retest reliability of passive and active movements was 0.87 and 0.80, respectively.

Intervention

All the participants were treated using MFR technique by a physical therapist who has an experience in the MFR technique. The participants were asked to perform a prone position prior to apply the MFR technique. Dominant hand of the physical therapist was then placed on the area of superficial back line (i.e., hamstring, gastro soleus muscle and plantar fascia) at the affected side of lower extremity, with a gentle force as per the participants tolerance, slow movement along transverse plane of each muscle fiber[9, 10, 12] (Figure 1). In each time, the hand force was applied almost the same. The MFR technique was applied for 10 minutes per area, 3 times per week for 4 weeks (12 times).[14, 18]

Figure 1. *MFR technique on superficial back line of the effected lower extremity. Note: A: hamstrings muscle, B: gastrocnemius muscle and achilles tendon, C: plantar fascia.*

Statistical analysis

SPSS version 19.0 was administered for statistical analyses. Shapiro-Wilk test was used to analyze the data distribution. One-way repeated measure analysis of variance (ANOVA) was used to analyze differences of ROM of hip flexion, knee flexion, and ankle dorsiflexion among three time points (i.e., before, immediate, and 4 weeks after intervention). The level of statistical significance was set at $p<0.05$.

Results

Fifteen individuals with chronic stroke (9 males), who had a mean age of 48.20 (SD=5.38) years, a mean body weight of 70.05 (SD=14.60) kg., height of 161.27 (SD=5.70) cm, and body mass index of 26.76 (SD=4.30) kg/m^2, were presented in this study. An average time of stroke onset was 34.27 (SD=5.17) months. There were 10 participants of hemorrhagic stroke and 5 infarction strokes. Five participants were affected with right side while the other 10 participants affected with left side. Eight participants could walk independently, whereas 7 participants could walk with a tripod cane. Underlying diseases was including two hypertension, two diabetes mellitus and one dyslipidemia. There were 7 participants who had a Modified Ashworth Score (MAS) score of "1+" (slight increase in muscle tone, manifested by a catch followed by minimal resistance through the remainder of the range of motion but the affected part is easily moved) and 8 participants with MAS score of "2" (more marked increase in muscle tone through most of the range of movement, but affected part easily moved).[19] All characteristics of participants were demonstrated in Table 1.

The results showed that ROMs of hip flexion, knee flexion, and ankle dorsiflexion during passive and active movements were significantly higher at immediate and 4 weeks after intervention when compared to their baselines as showed in Table 2 ($p<0.05$).

Table 1 Characteristics of the participants.

Characteristics	Mean±SD
Gender (male : female)	9:6
Age (year)	48.20±5.38
Height (cm)	161.27±5.70
Weight (kg)	70.05±14.60
Body mass index; BMI (kg/m^2)	26.76±4.30
Time of stroke onset (month)	34.27±5.17
Modified Ashworth Score (MAS)	
Score of 1+	7
Score of 2	8
Underlying disease	
Hypertension (n)	2
Diabetes mellitus (n)	2
Dyslipidemia (n)	1
Type of stroke	
Hemorrhage (n)	10
Infarction (n)	5
Affected side	
Right (n)	5
Left (n)	10
Using assistive device during walking	
No (n)	8
Tripod cane (n)	7

Note: *Data are expressed as mean±SD, otherwise as indicated, SD: standard deviation, n: number.*

Table 2 Mean ROM between pre-test, immediate and post 4 weeks of MFR intervention of passive and active movements.

	Range of Motion (ROM) (°)			*p* value
	Pre-test	Immediate	Post-test	
Passive movement				
Hip flexion (°)*	113.87±11.22	120.27±9.53[b]	122.13±9.57[a]	0.000
Knee flexion (°)*	136.40±5.15	141.13±5.04[b]	143.73±6.7[a]	0.000
Ankle dorsiflexion (°)*	29.87±2.45	35.33±2.38[b]	37.07±2.60[a]	0.000
Active movement				
Hip flexion (°)*	103.20±10.76	108.87±10.63[b]	112.80±9.44[a]	0.000
Knee flexion (°)*	120.67±8.92	126.67±8.52[b]	129.40±8.32[a]	0.000
Ankle dorsiflexion (°)*	0.53±0.64	1.93±1.58[b]	1.33±0.97[a]	0.003

Note: *[a]significant level between pre and post-test of ROM after using MFR intervention (p<0.05), [b]significant between pre and immediate test of ROM after using MFR intervention (p<0.05), *mean±SD, °degrees, SD: standard deviation.*

Discussion

The aim of this preliminary study was to determine the effect of MFR technique on ROM of hip flexion, knee flexion and ankle dorsiflexion changing at the affected side of lower extremity in individuals with chronic stroke. Findings of this study demonstrated significant improvements of the ROMs of hip flexion, knee flexion and ankle dorsiflexion during passive and active movements after immediate and 4 weeks after using MFR technique. These findings are in line with the previous studies reporting beneficial effects of MFR technique on improved lower extremity functions in several populations.[12, 13] Silva *et al.*[13] investigated the effect of MFR in individuals with post-op total knee arthroplasty found a significant increase of knee flexion. In addition, Kalichman and David[12] reported that self MFR using a foam roller at hamstring muscle could increase joint ROM and muscle flexibility in athletes. These increased joint ROMs may be explained by altering in muscle flexibility responsible for therapeutic pressure of MFR applied.[7]

Some proposed mechanisms attributed to the muscle flexibility changes involve with interfibrous tissue change muscle spindle and Golgi Tendon Organ (GTO) responses. During MFR technique, pressure applied might contribute to a reduction of interfibrous tissue adhesion and increase of temperature at the interfibrous tissue, which might lead to enhanced muscle flexibility.[9, 12] Additionally, rapidly released GTO and continuously facilitated stretch reflex might be occurred due to stress pressure performed on tendon, which might reduce muscle contraction and consequently increased muscle flexibility and increased ROM.[20] The MFR technique is an applying of external force combined with manual traction and prolonged assisted stretching maneuvers for breaking up fibrous tissue adhesive in muscle. This technique also requires low load and long duration which contributes to stretch on the myofascial complex in order to restore an optimal length, consequently improving muscle flexibility and function.[8, 9] MFR is transferred to other connective tissue structures for establishing a balance between the tension and the compressive force of the joint.[21] Luomala *et al*.[22] suggested that movement dysfunction may be induced by the modifications of connective tissue, which generates disarrangement of the surrounding fascia's structure, compromising the sliding system between layers. Furthermore, gentle pressure with light weight increase flows in extracellular matrix and interstitial fluids,[23] and elongate viscoelastic fascia,[14] resulting in flexible muscular structures.

Few limitations in this study should be concerned. Firstly, an effectiveness of the MFR technique on outcomes might be limited due to lack of control group compared. Secondly, this study investigated only one outcome aspects impaired in individuals with chronic stroke. Further study should confirm the effectiveness of the MFR technique on function such as balance and walking ability in this population. Lastly, force level applied during the MFR technique was difficult to regulate. We suggest for further study to evaluate force level applied objectively by asking a pain score during applied force or patient tolerance level.

Conclusion

The preliminary study concluded that MFR technique applied on superficial back line had significantly immediate effects and 4 weeks after the intervention effects on improved ROMs of hip flexion, knee flexion, and ankle dorsiflexion in the affected side of lower extremity in individuals with chronic stroke. The MFR technique may be used as an alternative treatment combined with general training program for stroke rehabilitation.

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