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Optimizing Recovery: A Comparison of 15 vs 30 Minutes of Effleurage Massage Combined with Lime Oil for Hamstring Injuries

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Abstract: Hamstring injury is a muscle injury in the back of the thigh due to stretching or tearing. This study compared the acute effects of a combination of effleurage and lime essential oil for 15 and 30 minutes on pain reduction and ROM improvement. Using a quasi-experimental design with two-group pretest-posttest, this study involved 36 runners from the Kalcerun community. Experimental group I and experimental group II. Group division is distinguished based on the mean results of the pre-test data. Experimental group I will be given the acute effect treatment of a combination of effleurage masque and lime essential oil measured after 30 minutes. Experimental group II will be given the treatment of acute effects of a combination of effleurage massage and lime essential oil measured after 15 minutes. Results showed that the 30-minute group had a greater decrease in tenderness (4,222 and 2,667) and stretching pain (4,500 and 1,833) than the 15-minute group. The increase in ROM of flexion (132.389 and 128.611) and extension (13.167 and 11.111) was also more significant in the 30-minute group. The 30-minute therapy was more effective in reducing pain and increasing ROM than 15 minutes, providing optimal therapeutic benefits for recreational runners.

Keywords: Injury, Effleurage, Hamstring, Lime Essential Oil.

INTRODUCTION

Physical activity, whether performed indoors or outdoors, carries the risk of reducing physical fitness and disrupting daily activities (Change et al., 2021). The human body is designed for movement, but improper preparation or technique can lead to overuse and injury. During physical activities, various tissues such as muscles, joints, and bones are engaged; however, excessive loads or incorrect movements may cause injuries resulting in pain, swelling, redness, and reduced functional ability (Ernawati et al., 2023). Research indicates that muscle injuries in sports account for up to 92% of cases in the four major lower limb muscle groups, with the highest prevalence in the hamstrings (37%), followed by adductors (23%), quadriceps (19%), and calves (13%) (Romero-Morales et al., 2024). Men are more susceptible to musculoskeletal disorders than women, with prevalence rates ranging from 28.7% to 59.4%. Overall, musculoskeletal disorders represent 56.40% of occupational diseases, and in Indonesia, their prevalence reaches 74% (Sari et al., 2024).

Hamstring injuries are particularly common in running sports, affecting 46.61% of short-distance runners and 54.47% of long-distance runners. The most frequent injury sites are the knee (22.38%), hamstrings (19.18%), and ankle (13.29%), with 79% occurring during training and 16% during competition (Mayooran S., 2019). Hamstring strains are typically caused by overload during hip flexion and knee extension movements, such as reaching or kicking, as well as unnatural postures, prolonged repetitive sitting with flexed knees, and resulting fatigue (Martin et al., 2022; Sari et al., 2024). These injuries involve excessive stretching of hamstring tissue, leading to pain through inflammatory processes, especially those involving eccentric muscle contractions (Rovendra, 2021; Harahap et al., 2023).

Grade 1 hamstring injuries are managed non-operatively using rest, ice, compression, and elevation (RICE), along with NSAIDs and analgesics for pain and inflammation control (Martin et al., 2022; Hammond et al., 2021). Massage therapy, particularly effleurage—a gentle stroking technique using palms and fingertips in circular motions—enhances venous and lymphatic flow, reduces pain and fatigue, improves circulation, relaxes tense muscles, and operates via the Gate Control Theory to inhibit pain signals (Dewi, 2018; Wibowo & Tsaqif, 2021; Graha, 2023). Although massage effectively reduces muscle tension and pain in the short term, its effects on anxiety are limited (Groninger et al., 2023).

To extend pain relief, combining massage with herbal remedies offers a promising approach. Lime (Citrus aurantifolia) essential oil is selected for its anti-inflammatory properties, derived from

antioxidants such as limonene, flavonoids, and vitamin C, which aid cell regeneration and alleviate muscle tension (Adi et al., 2017; Gattuso et al., 2017; Ana et al., 2022). It is favored for its refreshing aroma, non-sticky texture, and lack of visible residue, making it practical and safe compared to synthetic drugs (Katzung, 2022).

This study is essential to compare the acute effects of effleurage massage combined with lime essential oil on hamstring pain reduction. It addresses the need for more effective, efficient, and natural treatment options. Preliminary observations among 64 respondents revealed that 56.9% experienced mild hamstring pain after sports activities, only 30.8% knew how to manage muscle tension, and the acute pain-relieving effects of lime essential oil on hamstrings remain unknown. The findings are expected to contribute evidence-based protocols for medical and sports rehabilitation.

METHODS

Experimental group I and experimental group II. Group division is distinguished based on the mean results of the pre-test data. Experimental group I will be given the acute effect treatment of a combination of effleurage masque and lime essential oil measured after 30 minutes. Experimental group II will be given the treatment of acute effects of a combination of effleurage massage and lime essential oil measured after 15 minutes. This study was conducted at the Indonesian Traditional Medicine Massage Labaoratory, Faculty of Vocational Studies. The research was conducted on January 4 - February 12, 2025.

Population is the whole object / subject of research, while the sample is a part or representative that has representative characteristics of the population. The population in this study were members of the Kalcerun Community. The sample of this study was 36 people with a two-group sampling system and inclusion and exclusion criteria. Data Collection Techniques and Instruments Data collection techniques and instruments in this study are VAS (Visual Analog Scale), ROM (Range of Motion) with a goniometer, interview, and stopwatch.

RESULTS AND DISCUSSION

The present study investigated the comparative acute effects of 15-minute versus 30-minute effleurage massage combined with lime essential oil on hamstring pain. The research was conducted from January 4 to February 12, 2025, involving 36 participants from the Kalcerun running community who met the predefined inclusion and exclusion criteria.

Table 1. Percentage of age groups of research subjects

No.	Age	Amount	Percentage
1	16-20	11	31%
2	21-25	17	47%
3	26-30	4	11%
4	31-35	3	8%
5	36-40	1	3%
Total		**36**	**100%**

The age of participants in both experimental groups ranged from 16 to 39 years, with a mean age of 22.8 years. Hamstring pain was most prevalent among younger age groups. The distribution from highest to lowest frequency was as follows: 21–25 years: 17 participants (47%); 16–20 years: 11 participants (31%); 26–30 years: 4 participants (11%); 31–35 years: 3 participants (8%); 36–39 years: 1 participant (3%). The detailed age distribution of the participants is presented in Table 1.

Table 2. Occupation percentage of research subjects

No.	Job	Amount	Percentage
1	Teacher	3	8%
2	Student	14	39%
3	Merchants	3	8%
4	Students	7	20%
5	Civil Servant	4	11%
6	Self Employed	3	8%
7	Wirausaha	2	6%
Total		**36**	**100%**

The occupations of participants in both experimental groups included teachers, students, civil servants (PNS), traders, self-employed individuals, and entrepreneurs. Hamstring pain was most prevalent among certain occupational groups. The distribution from highest to lowest frequency was as follows: Students: 21 participants (59%); Civil servants: 4 participants (11%); Teachers: 3 participants (8%); Self-employed: 3 participants (8%); Traders: 3 participants (8%); Entrepreneurs: 2 participants (6%). The detailed occupational distribution is presented in Table 2.

Table 3. Indicators of the results of measuring the tenderness scale

Indicator	*Pretest*	Percentage	*Posttest*	Percentage
Group 30 Minutes				
Mild	0	0%	15	83%
Medium	12	67%	3	17%
Heavy	6	33%	0	0%
Very Heavy	0	0%	0	0%
Group 15 Minutes				
Mild	0	0%	6	33%
Medium	11	61%	12	67%
Heavy	7	39%	0	0%
Very Heavy	0	0%	0	0%

Data collection in this study used Visual Analog Scale (VAS). There are several scales that can be grouped pain levels are as follows: Scale 0: no pain; Scale 1-3: pain feels mild; Scale 4-6: pain feels moderate; Scale 7-9: pain feels severe; Scale 10: pain feels very severe. In the pretest, the 30-minute group (n=18) showed moderate pain in most participants (12 participants, 67%), with the remainder experiencing severe pain (6 participants, 33%). Similarly, in the 15-minute group (n=18), moderate pain predominated (11 participants, 61%), followed by severe pain (7 participants, 39%). Posttest results indicated a marked reduction in pain intensity in both groups. In the 30-minute group, most participants reported mild pain (15 participants, 83%), with only a minority retaining moderate pain (3 participants, 17%). In the 15-minute group, the majority experienced moderate pain (12 participants, 67%), while one-third reported mild pain (6 participants, 33%). The results of the research analysis that has been carried out can be described in the table:

Table 4. Indicators of stretching pain scale measurement results

Indicator	*Pretest*	Percentage	*Posttest*	Percentage
Group 30 Minutes				
No Pain	0	0%	2	11%
Mild	0	0%	15	83%
Medium	13	72%	1	6%
Heavy	5	28%	0	0%
Very Heavy	0	0%	0	0%
Group 15 Minutes				
No Pain	0	0%	0	11%
Mild	0	0%	4	22%
Medium	9	50%	14	78%
Heavy	9	50%	1	6%
Very Heavy	0	0%	0	0%

The table of indicators of the results of the measurement of the stretching pain scale above shows that of the total research sample in the measurement of pretest stretching pain in the 30-minute group most samples occurred moderate pain, namely 13 people or 72% and for severe pain as many as 5 people or 28%. Whereas in the 15-minute group most samples had moderate pain, namely 9 people or 50% and for severe pain as many as 9 people or 50%. Meanwhile, the results of the posttest stretching pain measurement showed that of the total research sample, most samples in the 30-minute group had decreased pain, namely no pain as many as 2 people or 11%, mild pain as many as 15 people or 83% and moderate pain as many as 1 person or 6%. Whereas in the 15-minute group most samples decreased pain, namely mild pain as many as 4 people or 22%, moderate pain as many as 14 people or 78%, and severe pain 1 person or 6%.

The first hypothesis test using the Independent T Test was carried out on the SPSS 26.00 for windows application, the test results can be seen in the following table:

Table 5. First Hypothesis Test Results with Independent T Test

Variable	t	Significance	Mean Difference	Description
Tenderness	5,442	0,000	1,917	Significant
Stretching Pain	4,554	0,000	1,639	Significant

Based on the data from the first hypothesis test using the Independent T Test in the table above, it is known that the variables of tenderness and stretching pain have a p value <0.05, so there is an effect of a combination of effleurage massage and lime essential oil in the 15-minute and 30-minute groups on reducing hamstring injury pain in recreational runners or H1 and H2 are accepted and H0 is rejected. The Independent T Test used to test the second hypothesis was carried out in the SPSS 26.00 for windows application, the test results can be seen in the following table:

Tabel 6. Second Hypothesis Test Results with Independent T Test

Variable	t	Significance	Mean Difference	Description
ROM Flexion	-3,925	0,000	-4,167	Significant
ROM Extension	-3,253	0,000	-2,306	Significant

Based on the data from the first hypothesis test results using the Independent T Test in the table above, it is known that the Flexion ROM and Extension ROM variables have a sig value. 0.000 or <0.05, so there is an effect of a combination of effleurage massage and lime essential oil in groups of 15 minutes and 30 minutes on increasing the ROM of hamstring injuries in recreational runners or H1 and H2 are accepted and H0 is rejected. The third hypothesis test using an independent t test is carried out on the SPSS 26.00 for windows application, the test results can be seen in the following table:

Table 7. Third Hypothesis Test Results with independent t test

Variable	Std. Error Difference	F	Significance	Description
Pressure Pain	0,352	0,223	0,000	Significant
Stretching Pain	0,360	0,333	0,000	Significant
Flexion ROM	1,062	0,430	0,000	Significant
Extension ROM	0,709	0,868	0,002	Significant

Based on the data from the hypothesis test results above, it is known that the four variables, namely tenderness, stretching pain, ROM Flexion, and ROM Extension, have a significance value of 0.000 or <0.05, so there is a difference in acute effect between the combination of effleurage masque and lime essential oil 15 minutes and 30 minutes on reducing pain and increasing ROM in hamstring muscle injuries or H1 is accepted and H0 is rejected. To test the effectiveness between the two experimental groups on reducing pain and increasing ROM in hamstring injuries can be seen in the following table:

Table 8. Effectiveness results of both groups with Marginal Mean

Variable	Group	Mean
Pre- Pressure Pain	15 Minute	6,278
	30 Minute	6,000
Post- Pressure Pain	15 Minute	4,222
	30 Minute	2,667
Pre- Stretching Pain	15 Minute	6,444
	30 Minute	5,833
Post- Stretching Pain	15 Minute	4,500
	30 Minute	1,833
Pre- Flexion ROM	15 Minute	124,333
	30 Minute	124,556
Post- Flexion ROM	15 Minute	128,611
	30 Minute	132,389
Pre- Extension ROM	15 Minute	8,222
	30 Minute	9,389
Post- Extension ROM	15 Minute	11,11
	30 Minute	13,167

Based on the results of the marginal means in the table above, it is known that tenderness has decreased where in the 30 minutes> 15 minutes group (2.667> 4.222), stretching pain has decreased where in the 30 minutes> 15 minutes group (1.833> 4.500), ROM flexion there is an increase in the 30 minutes> 15 minutes group (132.389> 128.611), ROM extension there is an increase in the 30 minutes> 15 minutes group (13.167> 11.111), so that the 30-minute group data is more effective in reducing pain and increasing ROM.

Massage Mechanisms in Reducing Pain and Increasing Range of Motion (ROM)

The body's inflammatory response to hamstring muscle injuries involves efforts to eliminate irritants, repair damaged tissues, and neutralize or destroy invading substances. Inflammation, therefore, represents a natural protective mechanism that facilitates the destruction of harmful organisms and promotes tissue healing (Tinesya et al., 2019). Thus, the pain and inflammation associated with injury can be considered beneficial, as they trigger the body's automatic repair processes for damaged tissue. One of the interventions administered in this study to alleviate pain in patients with hamstring muscle injuries was effleurage massage. Numerous studies have demonstrated that effleurage massage exerts acute effects in reducing pain while enhancing tissue flexibility and range of motion (ROM). The underlying mechanism involves the gate control theory of pain, which diminishes pain sensitivity at higher levels of the central nervous system (Pratiwi, 2019). Light touch and gentle pressure stimulate large-diameter sensory nerve fibers, thereby inhibiting the transmission of pain signals carried by smaller fibers to the brain. This non-noxious stimulation effectively "closes the gate," reducing the perception of pain (Andari, 2018).

Physiologically, massage influences muscles, blood circulation, and the nervous system. It helps mitigate inflammation by reducing myofascial adhesions and mobilizing fluid deposits (Graha, 2023). The effleurage technique increases local blood flow to spastic or inflamed muscles, which facilitates the clearance of pain-inducing substances such as bradykinin, prostaglandins, and TNF-α. Simultaneously, enhanced circulation delivers oxygen and nutrients to injured tissues, accelerating healing and further alleviating pain (Ayu & Harista, 2023). These findings align with those of Sriwijaya et al. (2018), who reported that effleurage massage reduces pain because tactile and nociceptive sensations follow distinct neural pathways. Smaller pain fibers transmit impulses more slowly than larger tactile fibers. When both are activated concurrently, tactile stimulation can override or diminish pain perception in the brain via the gate control theory.

To address restricted ROM in hamstring injuries, effleurage massage was also applied. The results of the present study are consistent with Widhiyanti (2017), who found that massage promotes muscle relaxation, pain reduction, improved circulation, and greater flexibility. Systematic effleurage manipulations enhance blood flow, relieve muscle tension, and reduce tissue adhesions through mechanotransduction mechanisms. According to Wang and Thampy (2020), the mechanical pressure from effleurage massage stimulates fibroblast activity, which is responsible for extracellular matrix production and maintenance. This process improves tissue structure, decreases adhesions, and ultimately increases the flexibility of muscles and connective tissues.

Mechanism of Lime Essential Oil in Pain Reduction and ROM Improvement

The lime essential oil administered in this study served as the massage medium during effleurage application. Lime essential oil contains bioactive compounds such as flavonoids, linalool, and linalyl acetate. Upon topical application, these compounds are rapidly absorbed into the bloodstream, exerting prompt and sustained effects on muscle tissue. Furthermore, lime essential oil is considered safe, as its components penetrate deeper skin layers, undergo rapid metabolism without risk of accumulation, and are quickly excreted from the body (Harahap et al., 2023). This is supported by Suja et al. (2017) in their study titled "Phytochemical screening, antioxidant, antibacterial activities of citrus limon and citrus sinensis peel extracts," which demonstrated that lime essential oil provides both physical and psychological relaxation due to linalool and linalyl acetate. Pharmacokinetically, these compounds are effectively absorbed transdermally during massage, entering the circulation to act directly on muscles and deliver prolonged relaxation.

These findings align with Harahap et al. (2023), who reported that flavonoids act as antioxidants with anti-inflammatory properties by inhibiting cyclooxygenase-2 (COX-2) enzyme activity, thereby

slowing the inflammatory cascade. Flavonoids also suppress the production of proinflammatory cytokines, including TNF-α, which reduces prostaglandin synthesis from arachidonic acid and consequently alleviates pain. In addition to flavonoids, linalool and linalyl acetate contribute significantly to analgesia. Consistent with Yuandira et al. (2021), linalool stimulates the thalamus to release enkephalins—endogenous pain-relieving peptides. Thus, the application of lime essential oil reduces pain through the combined actions of linalool, linalyl acetate, and flavonoids, which promote enkephalin release, inhibit COX-2, and attenuate inflammation.

Moreover, this study observed a greater improvement in flexibility (range of motion, ROM) in the 30-minute group compared to the 15-minute group. This enhanced ROM resulted from reduced inflammation at the injury site. Inflammation manifests clinically as rubor (redness), calor (heat), tumor (swelling), dolor (pain), and functio laesa (loss of function). Redness and heat arise from arteriolar dilatation and increased microvascular blood flow, while swelling compresses nerve endings to provoke pain. Loss of function reflects impaired movement in the affected joint or tissue. The combined intervention of effleurage massage and lime essential oil mitigated these inflammatory signs, thereby restoring functional mobility and increasing range of motion.

Comparison of Effectiveness in Both Groups

The Estimated Marginal Means analysis compared the effectiveness of the 15-minute and 30-minute effleurage massage treatments combined with lime essential oil across several variables: tenderness, stretching pain, flexion range of motion (ROM), and extension ROM. Pretreatment tenderness levels were comparable between groups. Posttreatment, however, the 30-minute group demonstrated a substantially greater pain reduction (mean = 2.667) compared to the 15-minute group (mean = 4.222). A similar pattern emerged for stretching pain: although the 15-minute group exhibited higher baseline levels (mean = 6.444) than the 30-minute group (mean = 5.833), the latter achieved a more pronounced reduction posttreatment (mean = 1.833 versus 4.500 in the 15-minute group). This indicates superior efficacy of the longer duration in alleviating stretching pain.

Flexibility improvements, measured by flexion and extension ROM, were also more substantial in the 30-minute group. Overall, these findings demonstrate that a 30-minute treatment duration is more effective than 15 minutes, particularly in reducing tenderness and stretching pain while enhancing joint mobility. Consequently, the 30-minute protocol is recommended for achieving optimal outcomes in pain relief and functional restoration. The superior performance of the longer duration can be attributed to the time required for the bioactive compounds in lime essential oil to penetrate the skin and exert their therapeutic effects. In the 15-minute intervention, these compounds may not fully traverse the epidermal and dermal layers to reach the hypodermis and underlying vasculature, limiting their distribution to deeper muscle tissues. In contrast, the extended 30-minute massage allows greater transdermal absorption, facilitating interaction with subcutaneous fat and blood vessels. Once in the systemic circulation, the compounds-particularly flavonoids-can effectively inhibit cyclooxygenase (COX) enzymes, thereby blocking prostaglandin synthesis from arachidonic acid and attenuating inflammatory mediators. This prolonged exposure ultimately results in more significant reductions in pain and inflammation.

CONCLUSION

Based on the research findings, it can be concluded that both the 15-minute and 30-minute effleurage massage treatments combined with lime essential oil produced significant acute reductions in tenderness and stretching pain, along with notable improvements in knee flexion and extension range of motion (ROM). However, the 30-minute group demonstrated superior outcomes, likely due to the longer duration allowing greater penetration and reaction time for the bioactive compounds in lime essential oil. The study recommends that runners in the Kalcerun community and recreational runners experiencing hamstring injuries adopt this combined effleurage massage and lime essential oil therapy to effectively alleviate pain and enhance knee ROM. For future researchers, further investigation is encouraged to explore the duration of these therapeutic effects and to refine the protocol for broader application.

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