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The Combination of Massage and Proprioceptive Neuromuscular Facilitation to Improve Range of Motion After Ankle Injury in Football Athletes of Universitas Negeri Jakarta

Salsa Bila Raif Sargyono*[1], Samsudin[2] , Ela Yuliana[3] , Fatah Nurdin[4], Kuswahyudi[5], Nadya Dwi Oktafiranda[6]
[1-6]Department of Sport Science, Universitas Negeri Jakarta, Indonesia
*Corresponding Author. E-mail: raifsalsabila123@gmail.com

Abstract: Ankle injuries are common among football athletes and often result in symptoms such as limited movement or decreased range of motion (RoM). The aim of this study was to investigate the effect of combining massage and Proprioceptive Neuromuscular Facilitation (PNF) in improving RoM following ankle injuries in athletes from the Performance Sports Club Football Team at Universitas Negeri Jakarta (UNJ). This study employed a pre-experimental design using a one-group pre-test and post-test model, with participants selected through purposive sampling. A total of 14 samples met the inclusion criteria. Ankle joint RoM was assessed using a goniometer during plantarflexion, dorsiflexion, eversion, and inversion movements. Measurements were taken before (pre-test) and after (post-test) the intervention, which was administered three times over the course of one week. Statistical analysis showed a significant improvement in the RoM for plantarflexion, dorsiflexion, and inversion ($P = 0.00$ or $P < 0.05$), but not for eversion ($P = 0.919$ or $P > 0.05$). These findings indicate that the combination of massage and PNF can effectively enhance ankle joint RoM in plantarflexion, dorsiflexion, and inversion, but not in eversion. This may be due to the anatomically limited eversion angle of the tibiotalar joint surface, which restricts eversion RoM. Consequently, the improvement in eversion RoM was not statistically significant after the intervention. However, the extent to which anatomical factors affect eversion RoM remains unclear and warrants further investigation.

Keywords: Massage, Propioceptive Neuromuscular Facilitation, Range of Motion, Ankle Injury

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INTRODUCTION

Ankle injuries are the most common type of injury experienced by football athletes (Cloke et al., 2009). Research findings indicate that the incidence rate of ankle injuries in male football players reaches 75.7%, while in female players it is 51% (Kolokotsios et al., 2021). Ankle injuries are more likely to occur during matches than during training sessions, with the most common injury mechanisms being non-contact (44.87%), contact with another player (44.73%), and contact with equipment such as the ball or goalpost (9.48%) (Gulbrandsen et al., 2019). Ankle injuries can damage the structural tissues around the joint, including ligaments, muscles, tendons, and nerves, potentially leading to various physical impairments such as joint proprioception deficits, balance disturbances, reduced muscle strength, and limited ankle range of motion (RoM), particularly dorsiflexion (Alahmari et al., 2020).

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Limited or decreased range of motion (RoM) is a common symptom observed after an ankle injury. This limitation may be caused by swelling and pain in the injured area due to damage to tissues such as ligaments, muscles, or tendons. In particular, restricted dorsiflexion following an ankle injury is considered a contributing factor to recurrent ankle injuries, as decreased dorsiflexion prevents the ankle from reaching a closed-packed position and holds it in a hyper-supinated state (Terada et al., 2013). Therefore, restoring full ankle joint RoM to pre-injury levels is essential to prevent further complications and recurrent injuries.

Massage is one of the methods commonly used to treat athletes who have sustained sports injuries (Pratama et al., 2020). Massage involves manual manipulation of body tissues, which can affect both the circulatory and nervous systems. The mechanical movement and pressure applied to the skin's surface can increase blood flow, release muscle tension, and reduce muscle stiffness (Gasibat & Suwehli, 2017; Weerapong et al., 2005), thereby promoting relaxation of soft tissues around the injured area. This, in turn, helps to improve movement function and joint RoM, since joint mobility requires support from surrounding soft tissues and stabilizing muscles (Jodi & Kushartanti, 2019). Several studies have reported that massage can enhance RoM after an ankle injury (Jodi & Kushartanti, 2019; Putro et al., 2023; Retnoningsih & Setyo Subyono, 2015; Sa'roni & Graha, 2019).

In addition to massage, which is known to be effective in improving RoM after ankle injury, stretching techniques such as Proprioceptive Neuromuscular Facilitation (PNF) are also recognized for their effectiveness (Yin et al., 2025; Lazarou et al., 2018). Stretching is an important part of the rehabilitation process for ankle injuries and serves as an effective exercise to enhance overall ankle joint performance (Alahmari et al., 2020). This is because injury-related muscle shortening occurs due to pathological conditions, and stretching is designed to increase the length of shortened soft tissue structures, thereby improving RoM (Alahmari et al., 2020). PNF is a stretching method proven to relax muscles, alleviate pain, increase joint RoM, strengthen muscle power, and improve stability, body coordination, and postural control (Yin et al., 2025). PNF is performed by stimulating proprioceptors to facilitate neuromuscular mechanisms in a simplified manner (Hernowo & Ambardini, 2019). PNF, or contract-relax techniques, involves assisted stretching through muscle contraction and relaxation. Techniques such as "contract-relax" or "hold-relax" are used to maximize RoM gains (Alahmari et al., 2020). Therefore, PNF is a recommended stretching technique to improve ankle RoM and function after injury (Lazarou et al., 2018).

Field observations revealed that many athletes from the Performance Sports Club Football Team at Universitas Negeri Jakarta (UNJ) have a history of ankle injuries, occurring both during matches and training sessions. However, most of these injuries are self-managed, resulting in residual symptoms such as restricted RoM, which interfere with daily activities and training. Given that in athletes from the Performance Sports Club Football Team at UNJ train nearly five times per week and actively participate in football tournaments, specialized treatment is necessary to prevent ankle injuries from impairing athletic performance. Considering the proven benefits of massage and PNF in enhancing RoM post-ankle injury, and based on the athletes' specific needs, the researcher was encouraged to combine these two methods massage and PNF to improve RoM. Empirical data is essential to determine the outcomes of such treatment; therefore, this study aims to investigate the effect of the combination of massage and PNF in improving RoM after

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ankle injury among in athletes from the Performance Sports Club Football Team at Universitas Negeri Jakarta.

METHODS

This study employed a pre-experimental design using a one-group pre-test and post-test model without a control group. The study was designed to examine the effect of massage and PNF manipulation on the improvement of ankle range of motion (RoM). The one-group pre-test–post-test design serves to compare the condition of participants before and after the intervention. The design model of this study can be illustrated as follows:

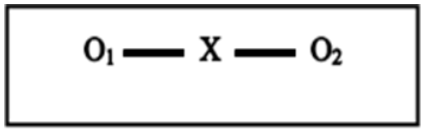

Figure 1. Research Design

Description:
O1 = Pre-Test Value (Before Manipulation)
X = Treatment of Massage and PNF
O2 = Post-Test Value (After Manipulation)

The population in this study consisted of football athletes from the Performance Sports Club Football Team at Universitas Negeri Jakarta who had a history of ankle injuries. A purposive sampling technique was used to select the research samples, resulting in a total of 14 individuals who met the inclusion criteria. The inclusion criteria established for this study were as follows.

1. Having experienced an ankle injury
2. Experiencing limited movement or reduced RoM following the ankle injury
3. Willing to participate as a research subject and having completed the informed consent form

Meanwhile, the exclusion criteria were as follows:

1. Suffering from an ankle injury accompanied by other injuries in the lower extremities
2. Presence of severe inflammation
3. Currently in the acute or early phase of the injury

The data collection process requires a joint measuring instrument to obtain data in the field during the study. The joint measuring instrument in this study was a goniometer to measure the RoM of the ankle joint in plantarflexion, dorsiflexion, eversion and inversion movements. Treatment in the form of massage and PNF was given 3 times a week. The data that had been obtained was analyzed descriptively, normality test. Paired samples t-test to determine the effect of the combination of massage and PNF in increasing RoM after ankle injury in athletes from the Performance Sports Club Football Team at Universitas Negeri Jakarta.

RESULT

Description of Sample Characteristics

Based on the descriptive analysis of the research subjects, it was found that in the group receiving massage and PNF treatment, 5 individuals (35.71%) were aged 18-19 years, 6 individuals (42.86%) were aged 20-21 years, and 3 individuals (21.43%) were

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aged 22-23 years. The majority of respondents had a body weight between 50-60 kg and a height between 155-165 cm. Regarding injury duration, 8 respondents (57.14%) had injuries lasting 1 month, 4 respondents (28.57%) had injuries lasting 2 months, and 2 respondents (14.29%) had injuries lasting 3 months. The causes of injury among the athletes were categorized as impact injuries in 2 individuals (14.29%), falls or sprains in 8 individuals (57.14%), and overuse injuries in 4 individuals (28.57%).

Pretest Results of Ankle Joint Range of Motion

Pretest data were obtained by measuring the ankle joint using a goniometer before the administration of massage and PNF treatments. Injured athletes were measured according to the established operational standards and measurement procedures to ensure valid data collection. The results are presented in Table 1.

Table 1. Pretest Ankle Results

	Pretest				
	N	Minimum	Maximum	Mean	Std. Deviation
Dorsiflexion	14	5˚	16˚	10,93	3.222
Plantarflexion	14	15˚	40˚	27,43	8.428
Eversion	14	15˚	26˚	19,64	3.028
Inversion	14	10˚	25˚	16,50	5.155

Based on the table above, it can be seen that the pretest data of ankle joint RoM for dorsiflexion, plantarflexion, eversion, and inversion were measured using a goniometer in degrees (˚). From the data, the mean dorsiflexion was 10.93˚ with a standard deviation of 3.222. The mean plantarflexion was 27.43˚ with a standard deviation of 8.428. The mean eversion was 19.64˚ with a standard deviation of 3.028, and the mean inversion was 16.50˚ with a standard deviation of 5.155.

Posttest Results of Ankle Joint Range of Motion

Posttest data were obtained by measuring the ankle joint using a goniometer after the massage and PNF treatments were administered. The athletes were measured according to established operational standards and measurement procedures to ensure the validity of the data. The results are presented in Table 2.

Table 2. Ankle Posttest Results

	Postest				
	N	Minimum	Maximum	Mean	Std. Deviation
Dorsiflexion	14	15˚	26˚	19.71	3.221
Plantarflexion	14	24˚	50˚	40.36	7.196
Eversion	14	15˚	26˚	19.79	3.239
Inversion	14	24˚	40˚	29.57	4.735

Based on the table above, it can be seen that the post-test data of ankle joint RoM for dorsiflexion, plantarflexion, eversion, and inversion were measured using a goniometer in degrees (˚). The mean dorsiflexion was 19.7˚ with a standard deviation of 3.221. The mean plantarflexion was 40.36˚ with a standard deviation of 7.196. The mean eversion was 19.79˚ with a standard deviation of 3.239, and the mean inversion was 29.57˚ with a standard deviation of 4.735.

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Average Difference Between Pretest and Posttest Results

Table 3. [Average Pretest and Posttest Results of Ankle Range of Motion]

	Pretest and Posttest Data		
	Pretest	Posttest	Difference
Dorsiflexion	10.93˚	19.71˚	8.79 ˚
Plantarflexion	27.43˚	40.36˚	12.93˚
Eversion	19.64˚	19.79˚	2.43˚
Inversion	16.50˚	29.57˚	13.07˚

Based on the table of average differences between pretest and posttest above, there were changes observed before and after the intervention. The mean dorsiflexion before the treatment was 10.93˚, which increased to 19.71˚ after the treatment. This difference indicates an improvement in dorsiflexion of 8.79˚. The mean plantarflexion before the treatment was 27.43˚, and after the treatment, it increased to 40.36˚, showing an improvement of 12.93˚. The mean eversion before the treatment was 19.64˚, and it increased slightly to 19.79˚ after the treatment, indicating an improvement of 0.15˚. The mean inversion before the treatment was 16.50˚, which increased to 29.57˚ after the treatment, indicating an improvement of 13.07˚.

Normality Test Results

Decision-making regarding whether the data are normally distributed can be determined from the significance values of the pretest and posttest data. If the normality test results show significance values for both pretest and posttest as $p > 0.05$, the data are considered to be normally distributed. The results obtained are presented in Table 4.

Table 4. [Normality Test Results]

Motion	Data	Sig.	Description
Dorsiflexion	Pretest	0.850	Normal
	Posttest	0.792	Normal
Plantarflexion	Pretest	0.148	Normal
	Posttest	0.407	Normal
Eversion	Pretest	0.279	Normal
	Posttest	0.817	Normal
Inversion	Pretest	0.245	Normal
	Posttest	0.117	Normal

Based on the table above, the results of the normality test for ankle joint RoM show that dorsiflexion has a pretest significance value of 0.850 and a posttest value of 0.792. Since both pretest and posttest significance values are $p > 0.05$, it can be concluded that the data are normally distributed. The normality test results for plantarflexion show a pretest significance value of 0.148 and a posttest value of 0.407. Both values are greater than 0.05, indicating normal distribution. For eversion, the pretest significance value was 0.279 and posttest 0.817, also showing normal distribution ($p > 0.05$). The inversion results showed pretest and posttest significance values of 0.245 and 0.117, respectively, confirming normal distribution as well. Since the RoM data for the ankle joint are normally distributed, parametric statistical analysis using the paired samples t-test will be conducted.

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Paired Samples t-Test Results

To determine the effect of the combination of massage and PNF in increasing the range of motion (RoM) after ankle injury in athletes from the Performance Sports Club Football Team at Universitas Negeri Jakarta, a paired samples t-test was conducted. The results are presented in Table 5.

Table 5. [Paired Samples t-Test Results]

Paired sample t-test					
Motion	Mean	Std. Deviation	t	df	Sig
Dorsiflexion	8.786	1.672	19.657	13	,000
Plantarfleksi	12.929	6.170	7.840	13	,000
Plantarflexion	143	5.187	103	13	,919
Inversi	13.071	5.181	9.440	13	,000

Based on the data in the table above, it is shown that three ankle joint RoM movements—dorsiflexion, plantarflexion, and inversion—have significance values of 0.000, which are less than 0.05 ($p < 0.05$). This indicates that massage and PNF have a significant effect in increasing the RoM of dorsiflexion, plantarflexion, and inversion after ankle injury. Meanwhile, the ankle joint RoM for eversion has a significance value of 0.919, which is greater than 0.05 ($p > 0.05$). This means that massage and PNF do not have a significant effect on improving eversion RoM after ankle injury.

DISCUSSION

The purpose of this study was to determine the effect of the combination of massage and PNF in increasing the range of motion (RoM) after ankle injury in athletes from the Performance Sports Club Football Team at Universitas Negeri Jakarta. Three ankle joint RoM movements—dorsiflexion, plantarflexion, and inversion—significantly improved after the application of massage and PNF. However, no significant improvement was found in ankle joint eversion RoM.

Massage has been proven to increase RoM following ankle injuries (Jodi & Kushartanti, 2019; Putro et al., 2023; Retnoningsih & Setyo Subyono, 2015; Sa'roni & Graha, 2019). Through biomechanical mechanisms, massage produces mechanical pressure on body tissues, which reduces passive and active stiffness and increases muscle flexibility, thereby enhancing RoM (Weerapong et al., 2005). Physiologically, the mechanical pressure from massage can help increase arteriolar pressure, improving blood flow, and the friction generated by massage manipulation raises skin and muscle temperature (Gasibat & Suwehli, 2017). Moreover, massage induces relaxation effects resulting from changes in parasympathetic activity and cortisol hormone levels (Gasibat & Suwehli, 2017; Weerapong et al., 2005). Neurologically, massage stimulates sensory receptors and reduces muscle tension. Muscle tension reduction occurs as massage pressure causes inhibitory effects and decreases nerve stimulation, as measured by the Hoffman reflex (H-reflex) (Weerapong et al., 2005), indirectly contributing to muscle relaxation. Supported by other studies, the physiological effects of manual therapy include improved blood circulation, endorphin hormone release, and muscle relaxation (Arovah, 2010). Thus, through these processes, massage can significantly increase RoM after ankle injury.

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PNF (Proprioceptive Neuromuscular Facilitation) is a stretching technique that has been proven to have a positive effect on increasing range of motion (RoM) (Yin et al., 2025; Lazarou et al., 2018). Hernowo & Ambardini (2019) stated that PNF is considered an essential element in fitness and conditioning programs designed to improve reduced joint mobility and decrease the risk of injury and reinjury. This is because, during the application of PNF, autogenic inhibition occurs in the stretched muscle (Hindle et al., 2012). Autogenic inhibition is believed to reduce muscle activity Spernoga et al., (2001) as inhibitory signals sent from the muscle's Golgi tendon organs (GTO) decrease muscle excitation, thereby reducing the efferent motor drive to the muscle Sharman et al., (2006) which allows relaxation and enables the muscle fibers to be stretched further (Spernoga et al., 2001). Furthermore, PNF also causes reciprocal inhibition, meaning that when the antagonist muscle contracts to maximize its contraction strength, the target muscle (TM) relaxes (Hindle et al., 2012). This relaxation permits the TM muscle fibers to stretch further (Spernoga et al., 2001). Relaxation occurs as a result of muscle stretching that increases proprioceptive structural inhibition in the TM and decreases nerve activity (Hindle et al., 2012). This is consistent with recent research indicating that PNF treatment has physiological effects that increase joint mobility and strengthen muscles that support and protect the joint, reducing pain and joint stiffness (Rafli & Utama, 2020). Thus, PNF results in a significant increase in RoM.

Meanwhile, in this study, it was found that the range of motion (RoM) of ankle eversion did not show a significant increase after the combined treatment of massage and PNF. This may be due to the fact that the eversion angle is smaller compared to the angles of dorsiflexion, plantarflexion, and inversion. Anatomically, the surface of the tibiotalar joint limits the RoM of eversion (Thiele et al., 2018). Therefore, the increase in RoM of eversion was not significantly different after the massage and PNF treatment. However, the extent to which this anatomical factor influences the RoM of eversion remains unclear and warrants further investigation. The limitation of this study is that it was conducted on a single treatment group without a control group. The sample size was also limited, and the results might differ if a larger sample were used. Future research should involve a control group and include a larger number of participants.

CONCLUSSION

The combination of massage and PNF has a significant effect on increasing the range of motion (RoM) of the ankle joint (dorsiflexion, plantarflexion, and inversion) following ankle injury in athletes from the Performance Sports Club Football Team at Universitas Negeri Jakarta. However, massage and PNF do not have a significant effect on increasing the RoM of ankle eversion. This may be due to the fact that the eversion angle is smaller compared to dorsiflexion, plantarflexion, and inversion angles, resulting in no significant difference in eversion RoM after the massage and PNF intervention. Nonetheless, the extent to which anatomical factors influence eversion RoM remains unclear, warranting further research.

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