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The effectiveness pre-operative exercise of muscle strength for early ambulation on lower limb fracture with measurement tool – The Modified Iowa Level of Assistance Scale (MILAS) – in hospital inpatients☆

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Abstract
Objective: To evaluate the effectiveness of pre-operative exercise of muscle strength before surgery, maintains muscle strength and prepare early postoperative ambulation lower limb fracture.
Method: Design research was a quasi-experiment with control and post-test only (unpaired *t*-test) with 28 respondents (14 respondents intervention group and 14 respondents control group). The intervention group was given muscle strength exercise before surgery, for ±1 week. Every day patients do strength exercise 3 times a day, for ±5–10 min. The post-operative assessment was conducted in both groups with Modified Level of Assistance Scale (MILAS), to find out the difference in the ability to do early ambulation.
Results: The results of the independent *t*-test were significant differences of ambulation ability of the intervention group were better than the control group. The difference in average ambulation ability after operation between the intervention group and the control group, the average ambulation ability of respondents in the intervention group was 14.14 with a standard deviation (SD = 2.93), while for the control group, the average ambulation ability was 18.50 with the standard deviation (SD = 5.56). Statistical test results obtained *p*-value of 0.017 ($\alpha < 0.005$), meaning that at alpha 5% a significant difference was seen in the average ability of early ambulation between respondents in the intervention group and the control group.
Conclusion: There is evidence to suggest that pre-operative exercise of muscle strength is beneficial to early ambulation postoperative lower limb fracture.

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Introduction

Physical activity plays an important role in the health of the human body. The body will react positively to physical activity. Less physical activity will reduce muscle size (atrophy) by decreasing contractility and strength.[1] Decreased physical activity such as hold their own weight, is a consequence of injuries such as fractures, diseases or conditions advanced age.[2]

Fractures hold the largest proportion of causes of trauma or injury, which can occur at any age level and can cause significant changes in the quality of life of individuals. Changes that occur include limited activity, due to pain, injury or fracture.[3] The pain experienced by patients, making patients afraid to move the injured limb, so that patients tend to remain lying down for long, leaving the body stiff. Individuals who restrict their movements, will cause unstable joint movement, muscle atrophy in 4–6 days.[4]

Prolonged immobilization will stimulate skeletal muscle atrophy, especially the lower extremities. During the immobilization period there is a decrease in muscle strength of 1–1.5% per day and up to 5.5% per day if immobilization is due to the installation of casts or fractures.[5] Previous studies have shown that after a short period of 10 days the muscles are not burdened or bed rest, the results are the first 4 days there is a decrease include in muscle strength to hold the load and after 6 weeks of bed rest, almost half of the muscle strength decreases.[6] Similar studies were also repeated by Berg, that bed rest can cause atrophy with a value of $p < 0.05$, namely in the extensor muscle of the gluteal region of 2%, knee extensors 4%, ankle plantar flexi 3%. In addition, the density of the proximal tibial bone decreased by 2% during bed rest for more than 5 weeks, with a p value <0.05.[7]

One way to prevent muscle atrophy due to prolonged immobilization in a fracture condition is to do early ambulation. Early ambulation is one of the nursing actions that starts from sitting on the edge of the bed, standing and walking using walking aids such as crutches.[8] The benefits of early postoperative ambulation reduced venous stasis, stimulating blood circulation, preventing deep venous thrombosis, pulmonary embolism, increasing muscle strength, coordination and independence and improving gastrointestinal function, genitourinary and pulmonary.[9] Postoperative early ambulation, which starts on the first postoperative day, provides significant changes. Early ambulation is done, the patient is recommended to do *dangling position*, that is, the patient sits on the edge of the bed, on the first day after surgery. The advantage of this initial activity is the reduction in length of stay from 16.8 days to 6 days to 4.3 days to 2.8 days and can reduce the degree of pain to below the value of 4.[10]

The patient's ability to perform early ambulation postoperatively is greatly influenced by the preparation of the patient before surgery including preoperative muscle strength training.[11] In doing muscle strength training, one of the network structures that plays an important role is the quadricep muscle. Quadricep muscle is a muscle in the gluteal and gastrocnemius regions, which can do long activities such as walking, running, jumping and kicking, so it is needed a strong and independent antigravity muscle function during post-surgery.[12] This muscle function can be maintained with an exercise program (exercise) before surgery.[13] Preoperative muscle strength training aims to increase the patient's readiness to perform early ambulation postoperatively.[9] In addition, to improve or determine better postoperative outcomes, minimize complications, and even shorter treatment time.[1]

Method

This research is a quantitative study, which aims to answer research questions or test research hypothesis.[14] The design of the study the researchers use a quasi-experimental approach to *post-test only with control group design* (*quasi experiment with control*). In this design there are two groups, namely the intervention group and the control group. The intervention group was carried out before the operation, in the form of muscle strength training before the operation while the control group was not intervened but followed the applicable standards in the hospital. The study was conducted on 28 respondents, before lower extremity operations, with 14 respondents in the intervention group and 14 respondents in the control group.

Researchers gave *preoperative muscle strength training*, in the intervention group, starting on the first day the patient entered the first to government hospital Karawang West Java Indonesia. Exercise for each patient is done 3 times in one day, and in one exercise duration of 5–10 min. The exercise is done according to the patient's tolerance, if the patient feels tired or sick, then the exercise is stopped, or resumed if the patient is able, until reaching the desired frequency. Because if the pain increases during exercise, there may be injury to the muscles, and the exercise will aggravate injury to the muscles.

The exercise was carried out for 6 days before surgery in the intervention group, whereas in the control group no intervention was performed and to meet the fairness considerations the control group patients were given interventions according to hospital SOPs such as an explanation of the importance of early mobilization and ambulation, i.e. from sitting to walking using crutches after surgery. After the patient underwent a fracture limb fixation surgery, the investigators assessed the ability of early ambulation, namely the ability of ambulation day 4 using the Modified Iowa Level of Assistance Scale (MILAS),[15] to both groups. The results of measuring the assessment with the MILAS are 0–30 (with a value of 0 is the best value).

Results

Univariate analysis

Univariate analysis of this study illustrates the distribution of respondent characteristics such as age, gender, type of fracture, and the use of traction on the group intervention or the control group, which is shown in Table 1.

Based on Table 1, the data obtained that the average age of respondents in the intervention group was 39.5 years with a standard deviation of 22.76 years. The youngest is 12 years old and the oldest is 96 years old. Based on the results of the interval estimation, it can be concluded that

Table 1 Distribution of respondents by age at Karawang Hospital in West Java 2018 ($n = 28$).

Age	Mean	Standard deviation (SD)	Min	Max	95% CI
Intervention group	39.50	22.76	12	96	26.36–52.64
Control group	50.07	25.68	18	92	35.24–64.9

Table 2 Distribution of respondents by gender, type of fracture and traction use at Karawang Hospital in 2018 ($n = 28$).

Variable	Group					
	Intervention		Control		Total	
	Amount	%	Amount	%	Amount	%
Gender						
Male	10	71.4	8	57.1	18	64.29
Female	4	28.6	6	42.9	10	35.71
Fracture type						
Tibial fibula	4	28.6	8	57.1	12	42.9
Femur	10	71.4	6	42.9	16	57.1
Use of traction						
Traction	9	64.3	6	42.9	15	53.6
Non-traction	5	35.7	8	57.1	13	46.4

95% is believed that the average age of respondents in the intervention group is between 26.36 years and 52.64 years old. While the average age of respondents in the control group was 50.07 years with a standard deviation of 25.68 years. The youngest is 18 years old and the oldest is 92 years old. From the interval estimation results it can be concluded that 95% are believed that the average age of respondents in the control group is between 35.24 years and 64.9 years.

Based on Table 2, it is found that the sex of the most respondents in both the intervention group and the control group was male. The most type of fracture in the intervention group was femoral fracture, i.e. 71.4% and, in the control, group were tibial fibula fractures. Whereas for the most use of traction in the intervention group that is 64.3%.

The results of Table 3 show that the average ability of early ambulation in the intervention group 14.14 is better than the control group 18.50.

Bivariate analysis

Bivariate analysis was performed to determine whether there was a significant relationship between the two variables or to find out whether there was a difference in the average ambulation ability in the intervention group that was given treatment in the form of preoperative muscle strength training with ambulation ability in the control group after surgery. The statistical test used in this study is the unpaired *t*-test. Before conducting an unpaired *t*-test, it must first be seen whether the data is normally distributed or not by the *Kolmogorov–Smirnov test of Normality test, Shapiro–Wilk*. In addition, a variant *Homogeneity test* was performed, namely the *Levene's variance* test to determine whether the data had the same variant or not.

Difference in mean ability for early ambulation after surgery between the intervention group and the control group

Based on Table 4 the average ambulation ability of the respondent in the intervention group is 14.14 with a standard deviation of 2.93, while for the control group the average ambulance ability is 18.50 with the standard deviation 5.56. Statistical test results obtained p value = 0.017, meaning that at alpha 5% a significant difference was seen in the average ability of early ambulation between respondents in the intervention group and the control group.

Contribution of confounding factors in *preoperative* muscle strength training to the early ambulation ability of postoperative respondents

From Table 5 showed that the age contributes strongly to the ability of early ambulation, either the intervention group or the control group. The results of this test indicated by a value of $r > 0.6$ which means it has a strong relationship and positive pattern means that the more you age, the more the level of ambulation assistance.

The contribution of the confounding variable to the ability of early ambulation in Table 6 is that the gender variable, the type of fracture, does not have a contribution to influence the ability of early ambulation in the intervention group, with a p value >0.05. Whereas the control group had a contribution. Variable use of traction has a significant contribution or influence on the ability of early ambulation in the intervention group with a value of $p = 0.035$ while in the control group the use of traction did not contribute.

Table 3 Distribution of respondents based on early ambulation capabilities at Karawang Hospital in West Java in 2018 ($n = 28$).

Early ambulation capabilities	Mean	Standard deviation (SD)	Min	Max	95% CI
Intervention group	14.14	2.93	9	20	12.5–15.8
Control group	18.50	5.56	10	25	15.3–21.7

Table 4 Difference in mean ability of early ambulation after operation between intervention and control groups at Karawang Hospital in 2018 ($n = 28$).

Early ambulation capabilities	Mean	SD	SE	*p*-Value
Intervention group	14.14	2.93	0.78	0.017
Control group	18.50	5.56	1.49	

Table 5 Contribution of age, in preoperative muscle strength training to early ambulation ability in the respondents group at Karawang Hospital West Java in 2018 ($n = 28$).

Variable	Group	Confounding	*r*	*p*-Value
Early ambulation	Intervention group	Age	0.63	0.003
	Control group		0.73	0.015

Multivariate analysis

The purpose of this multivariate analysis is to find out what confounding variables most influence the ability of postoperative early ambulation both in the intervention group and the control group by using multiple linear regression. The results of the analysis can be seen in Table 7.

The regression equations from Table 7 are as follows.

Based on R square (R^2) that is equal to 0.561 means regression line that can explain 56.1% of the variation early ambulation abilities are influenced by variables of age, the type of sex and intervention. Every time an intervention, will affect the ability of ambulation by 30.4% or about 0.3 time. The strength of the model amounted to 30.4%, meaning that the variable intervention preoperative muscle strength exercises, can explain the dependent variable (early ambulation abilities) a number 30.4%, the rest is the other independent variables in this study, or other variables that have not been identified in this study.

Discussion

Effects of preoperative muscle strength training on the patient's early ambulation ability post-operative

Based on the results of the study in Table 3, the results show that there are differences in the average early ambulation ability that is better in the intervention group compared to the control group, with a p value = 0.017. In theory this happens because muscle strength training can prevent muscle atrophy, because *isometric* muscle training can increase venous return, and maintain muscle strength in large muscle groups, quadricep and gluteal muscles.[16] Doing preoperative muscle strength training, the patient's *endurance* will be better maintained.[17] The energy to carry out activities is maintained, so that the patient has a better ability on the 4th postoperative day to carry out ambulation.[18] This is consistent with the opinion expressed by Do Kyung Kim[18] dos not to become dependent on others and be more independent in carrying out activities with rehabilitation.

According to Oldmeadow,[19] factors that influence the implementation of early ambulation of patients after surgery of lower extremity fractures are mental status, *pre-operative mobilization*, patient health conditions and social support.[19] This statement is also supported by Griffin,[20] that early ambulation is determined by the level of physical activity of the patient, the stability of the cardiovascular system and neuromuscular. One of the physical activities carried out by the patient, which can avoid the risk of muscle atrophy is by exercising both isometric and isotonic muscle strength.

The results also confirmed by Nielsen,[21] that an exercise program before surgery (*pre-habilitation*) can improve the function and shorten long day of hospitalization (*hospital stay*) without complications up or dissatisfaction with a value of $p = 0.0001$ ($p < 0.05$).

The impact of muscle strength training before surgery is to improve the ability of the patient's early ambulation postoperatively.[4] Early ambulation is an important component in the treatment of postoperative fractures because if the patient limits his movements in bed and does not carry out ambulation at all, the patient will be more difficult to start walking.

According to Berg, ambulation is a walking activity. Early ambulation is the stage of activities carried out immediately on the patient after surgery starting from getting up and sitting until the patient gets out of bed and starts walking with the help of tools in accordance with the

Table 6 Contributions to gender, type fracture and uses traction on exercise power muscle against preoperative ambulation ability Dini Group respondents at Hospital West Java in 2018 ($n = 28$).

Variable	Group	Confounding	Mean	SD	*p*-Value
Early ambulation		*Gender*			
	Intervention	Male	13.60	2.76	0.29
		Female	15.50	3.32	
	Control	Male	14.88	4.32	0.001
		Female	23.33	2.25	
	Intervention	Tibial fibula	13.00	2.97	0.219
		Femur	15.0	2.78	
	Control	Tibial fibula	16.30	4.95	0.012
		Femur	24.00	2.00	
	Intervention	Traction	12.00	1.87	0.035
		Non-traction	15.33	2.78	
	Control	Traction	16.63	5.45	0.152
		Non-traction	21.00	5.06	

Table 7 Analysis of the contribution of confounding variables to preoperative muscle strength training against the ability of early ambulation in the respondent group Karawang Hospital 2018 ($n = 28$).

Variable	*B*	Beta	R^2	*p*-Value
Constant	9.595		0.561	0.000
Age	0.091	0.456		0.004
Gender	3.289	0.328		0.028
Group	2.922	0.304		0.022

patient's condition.[22] Ambulation supports joint strength, endurance and flexibility and the benefits of exercise can slowly increase activity tolerance.[23]

Based on the results of the above study, nurses in the practice setting must think of conditions that accelerate the patient's ability to perform early ambulation postoperatively, without being dependent on the help of others. One way to consider this is to do muscle strength training before surgery.

Early ambulation ability

Based on the results of the study, it can be seen in Table 2 that the distribution of respondents in the intervention group had an average ambulation ability of 14.14 with the best ambulation value of 9 and poor ambulation 20. Those who had good ambulation ability in the intervention group were 8 people (57.1%) higher than the control group.

Maximum muscle work can improve one's work ability which in turn will increase productivity. One way to increase a person's productivity is to increase his ability to do *weight bearing* and ambulation activities.

Giving interventions in the form of muscle strength training to patients before surgery, it is expected that muscle strength is maintained and energy to maintain muscle strength can still be maintained, so that when the patient rests while waiting for the operating schedule, it is expected that muscle strength can be maintained.[24] At the time of post-surgery, it is expected that the patient can immediately perform early ambulation. Assumptions are also supported by the theory that normal individuals who experience bed rest will lose muscle strength an average of 3% a day (*atrophy disuse*).

Many people wants to know about the confounding factors, which mostly influence the dependent variable (ambulation ability) can be seen in Table 5, namely: there are 4 (four) variables that enter multivariate modeling, namely age, sex, type of fracture and use of traction.[25] Of the four variables, variables $p > 0.05$, namely the type of fracture and the use of traction, so that these variables are excluded from *multivariate* modeling. The final model obtained are the independent and *confounding* variables that affect the ability of ambulation, namely age, sex and the intervention of muscle strength training itself. But the biggest influence is the factor of age and gender.

Statistical test results found that there is a significant relationship between age and ambulation ability. The level of early ambulation is strongly influenced by age, meaning that the more you age, the more you need help from others, especially the elderly. It can be seen in the control group, that no intervention was carried out, that the level of ability to carry out ambulation was higher requiring help from others, compared to the intervention group being treated, the value of ambulation ability was 14.14, less needing help from others. Though seen from the value of equality, age in the intervention group, equivalent to age in the control group is $p = 0.26$.

This condition occurs because of a lack of research samples, and there are no restrictions on age and gender, so it will affect the results of the analysis. Therefore, adequate research samples are needed to obtain more significant results.[26] In addition, it is necessary to control the characteristics of age, so that differences in ambulation ability can be seen based on age level or based on sex.[24] The results of research with highly controlled samples, of course require quite a long time.

Conflict of interest

The authors declare no conflict of interest.

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