Effect of Post-Operative Exercise on Arteriovenous Fistula Maturation in Patients with Chronic Renal Failure: A randomized controlled trial.

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Abstract

Background: Nearly half a million people requiring hemodialysis, with approximately 100,000 new cases of end-stage renal disease (ESRD) on an annual basis. long-term survival of hemodialysis patients depends on the creation and maintenance of adequate vascular access. Accesses that were nonfunctional after six weeks of maturation are considered primary failures. **Aim of the Study:** This study aimed to evaluate the effect of post-operative exercise on arteriovenous fistula (AVF) maturation in patients with chronic renal failure. **Subjects and methods: Study design:** A parallel-group, 2-arm randomized controlled trial of exercise programs for AVF maturation, with single-blind design. **Setting:** The study conducted at vascular outpatient's clinic, Alexandria Main University Hospital, Alexandria governorate, Egypt. **Participants:** A purposive sample patient who admitted to the above-mentioned setting who are candidates for AVF creation were recruited. The sample size was 64 participants. **Tools**: Two tools were developed: Tool I: " Bio-demographic and clinical data assessment sheet " Tool II: " AVF Clinical maturation assessment sheet" Tool III: " AVF Ultrasound maturation ". **Results:** The results revealed that there is early maturation in the study group over control with statistical significance differences after 2 weeks and after 6 weeks (P=0.032 and 0.001) respectively. After 12 weeks' assessment 100% of study group and 93.75% of control group represent full AVF clinical maturation. Ultrasound maturation was showed significance difference after 6 weeks' assessment in the cephalic vein (P=0.012) and brachial artery (P=0.025). **Conclusion**: Significant clinical maturation assessment of AVF by inspection, palpation and auscultation is earlier and more visible in the study group patients, Furthermore, ultrasonic evaluations revealed accelerated maturation timelines in all study group participants relative to the majority of patients in the control group. **Recommendation**: It is recommended to include exercise program postoperatively for patients undergoing AVF procedures in treatment plan of these patients. Replicate this study on larger samples and on patients with other types of hemodialysis accesses.

Keywords: Arteriovenous fistula, Chronic renal failure, Maturation, Post-operative exercise.

Introduction

There are nearly half a million people requiring hemodialysis, with approximately 100,000 new cases of end-stage renal disease (ESRD) on an annual basis. long-term survival of hemodialysis patients depends on the creation and maintenance of adequate vascular access. There is a consensus that the ideal form of vascular access for hemodialysis is the native arteriovenous fistula (AVF). It is the method of choice for achieving vascular access in chronic hemodialysis patients. There are multiple types of arteriovenous (AV) hemodialysis access,

though autogenous AV access has higher patency rates, a lower risk of complications compared to prosthetic arteriovenous access, and lower health-care cost, low need for hospitalization, and low mortality risk and a lower risk of infection compared to temporary central venous catheters **(Segal & Qaja, 2024; Rosales etal, 2022; Mo et al, 2020).**

Accesses that were nonfunctional after six weeks of maturation were considered to be primary failures, while those that failed after previous successful dialysis were considered to be secondary failures. Delay in maturation or failure of fistula maturation increase morbidity of chronic hemodialysis patients. Exercises after AVF creation may help to improve fistula maturation **(Rosales Merlo et al, 2025).**

Exercise has been studied in patients with chronic renal failure following AVF surgery. It shown that postoperative isometric exercise (ISM) and isotonic exercise (IST) with free and unknown intensities do not provide superior effects on ultrasound and clinical maturation rates of AVFs **(Fontseré et al, 2016; López Alonso et al, 2015)**.

Upper limb exercise has been recommended to enhance AVF maturation in patients with chronic renal failure. It helps to improve AVF maturation through increasing hyperemia and muscle mass, decreasing superficial and increasing vein prominence **(Andrade et al, 2022; Cao et al, 2025; Ribeiro et al, 2024)**. However, the optimal postoperative exercise program for this population remains a subject of debate and ongoing research. The inconsistency in results among various exercise protocols inspired this study.

Significance of the study

The significance of this randomized controlled trial lies in its potential to address a critical clinical need by improving AVF maturation rates in patients with chronic renal failure, a key factor for successful hemodialysis. AVF maturation is essential for effective and sustainable vascular access, yet many patients experience delayed or failed maturation, leading to additional procedures and complications. This study evaluates the role of post-operative exercise programs as a cost-effective and non-invasive intervention to enhance AVF maturation. By employing a rigorous randomized controlled trial design, the study provides high-quality evidence to clarify inconsistencies in previous research regarding the effectiveness of such programs. The findings suggest that post-operative exercise may significantly improve clinical AVF maturation, particularly for distal accesses, which are often preferred but have lower maturation success rates. If proven effective, this intervention could improve patient outcomes, reduce healthcare costs, and provide a foundation for standardized post-operative care protocols. Ultimately, this research contributes to the growing body of evidence supporting exercise-based interventions and lays the groundwork for future research to optimize exercise timing, intensity, and duration for AVF maturation.

Objectives: This study aims to evaluate the effect of post-operative exercise on arteriovenous fistula maturation in patients with chronic renal failure.

Hypotheses:

Patients who perform post-operative exercise will exhibit mature arteriovenous fistula than those who don't perform it.

Materials and Methods

- **Study design:** A parallel-group, 2-arm randomized controlled trial of exercise programs for AVF maturation, with single-blinded design.
- **Setting:** The study conducted at vascular outpatient's clinic,

Alexandria Main University Hospital which services patients in Alexandria Governorate and neighborhoods.

- **Sample:** A purposive sample patient who admitted to the above-mentioned setting who are candidates for AVF creation were recruited. Sample size was 64 participants, it was estimated by G power version 3.1.9.7., with 80% power and 5% type I error. 105 patients were assessed for eligibility and 41 patients were excluded. The total sample size was 64 participants. They were divided randomly and alternatively into two equal groups, 32 in the exercise (study) group and 32 in control group (figure 1).

Inclusion criteria: patients who agreed to participate in the study, aged from 20-65 years, both sexes, diagnosed with CKD stage 4 to 5 and planned for AVF.

Exclusion criteria: patients with mental disorders, patients with musculoskeletal disorders, neurological disorders or unable to perform required exercises.

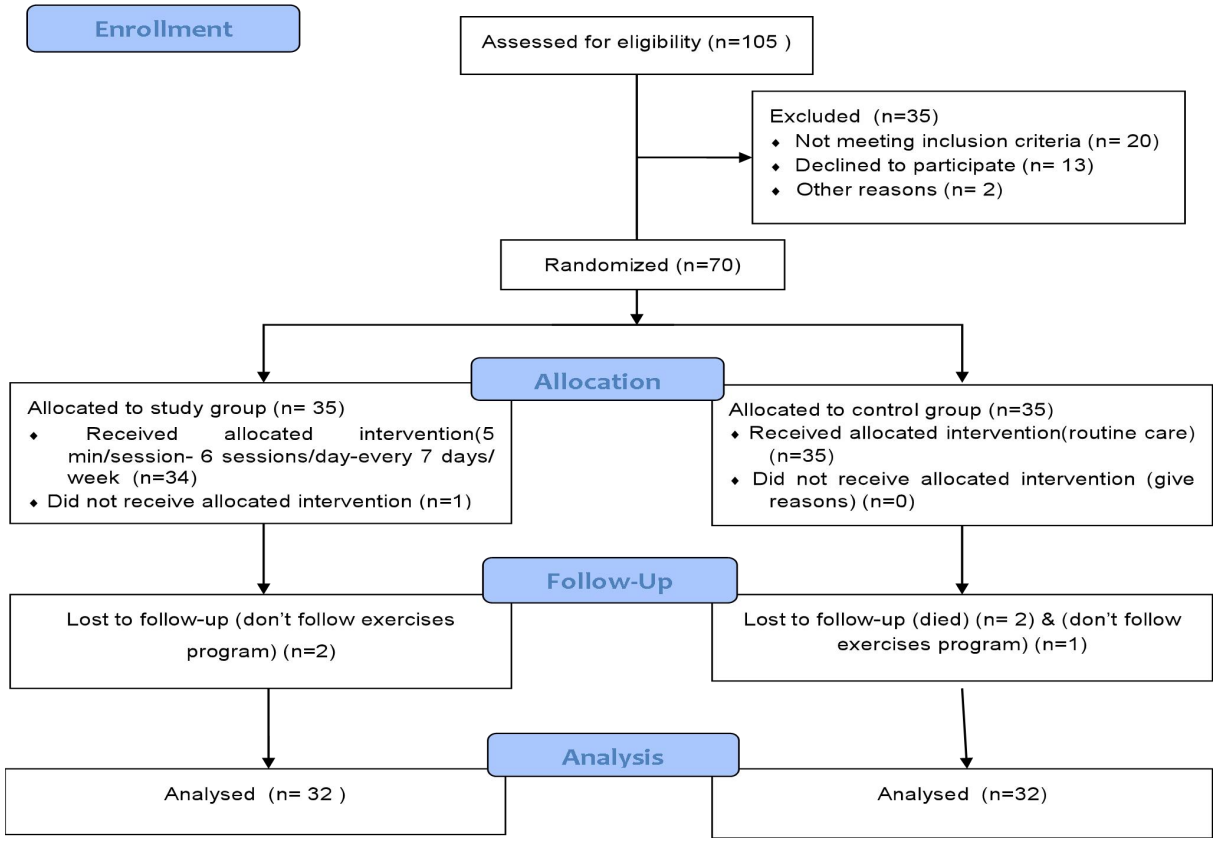

Figure (1): flow chart of participants' recruitment process

Tools:

Two tools were developed by the researchers based on reviewing the related literatures to accomplish the study aim:

Tool 1: Bio-demographic and clinical data assessment sheet

It was developed by the researchers to collect bio-demographic and clinical data. It Includes patients' age, gender, educational level, marital status, occupation, residence, smoking, history of chronic disease, and body mass index **(El-Deeb et al, 2017; Andrade et al., 2022)** and **(Sichona et al, 2023).**

Tool 2: AVF Clinical maturation assessment sheet

It was developed by researchers to collect data related to AVF maturation. It uses to evaluate AVF maturation clinically. It includes complete AFV examination through the following assessment parts **(Robbin et al, 2018; Correia et al, 2021; Salimi et al, 2017; Siddiqui et al, 2017; Gasparin et al, 2022).**

Part 1: Inspection this part is used to assess AVF maturation by observation, it contains 4 items including: distention of fistula site vein dilatation decreased or absence (not distended=1) or Present (distended=2), vein status during arm elevation, the researchers ask the patient to elevate the arm above the head, if the vein completely collapsed (AVF flat=2) it indicates that there is no obstruction in the veins, if the vein distended indicating that there is an obstruction in the vein (AVF distended=1). Then observe the patient arm is dependent position, effect of gravity, if fistula distended (distended=2) or flat (flat=1). Inspect the fistula site for presence of complication including infection signs as drainage or redness (present=1) or (absent=2).

Part 2: Palpation this part is used to assess AVF maturation by palpation, it contains 4 items including: consistency of the fistula site (soft or too hard=1) or (firm =2 indicate more blood flow), assess skin temperature above the fistula site warm (normal=2) cold or hot (abnormal=1), palpate for tenderness (present =1) or (absent=2), finally assess thrill (present=2) or (absent=1)

Part 3: Auscultation this part is used to assess AVF maturation by auscultation, it contains one item including: AVF auscultation for bruit (absent =1), (soft bruit = 2), or (louder and more continuous=3).

Scoring system: Each assessment has two to 3 findings for 9 items in the three parts, the assessment findings were calculated and scoring system equal to 1 to 6 indicates no maturation, 7-12 moderate maturation, 13-19 full maturation.

Tool 3: AVF Ultrasound maturation

It uses to assess AVF maturation by performing AVF Ultrasound (US) during follow up visit. It was performed after 2 & 6 weeks. Diameters of AVF were assessed by a blind assessor performing Doppler ultrasound **(Robbin et al, 2018)** and **(Liu et al, 2024)**. The increased the cephalic vein and brachial artery diameters, the better the maturation.

Steps of the study:

- **Validity of the tools:** it was tested by 7 experts, 4 experts in Medical Surgical Nursing Department, Alexandria Faculty of Nursing and 3 experts in Medicine, specialized in vascular surgery, Faculty of Medicine, Alexandria Main University Hospital.
- **Reliability of the tools:** The reliability of tools was done by using Cronbach's Alpha. Its result was 0.82.
- **Pilot Study:** was done in 7 patients. The needed modifications in the study tools were done. Patients included in

pilot study were excluded from the actual study sample.

Ethical Consideration:

- Ethical approval to perform the study was obtained from the Research Ethical Committee of Faculty of medicine, Alexandria university (Serial number 0307018).
- Approval permission to conduct the study was obtained from the specialized authority.
- The researchers introduced themselves to the study participants, then explained the study aim and written informed patients' consent were obtained before data collection.
- Anonymity and confidentiality were assured. Patients' right to voluntary withdraw at any time of research participation was considered and respected.

Data Collection:

The study group (I):

Firstly the researchers interviewed every participant separately before AVF surgery to collect patient's bio-demographic and clinical data using tool 1 and to explain exercises program using demonstration and re-demonstration including 4 types of exercises as the following: **(Nantakool et al, 2022)** and **(Siddiqui et al, 2017).**

1.Handgrip exercise: teach the patient to squeeze handgrip or tennis ball to improve both blood flow and pressure in the AVF.

2.Arm exercises include biceps and triceps extension to promote blood flow to the AVF, increase muscle strength and increase blood vessels size.

3.Fistula massage: instruct the patient to gently massage the area around the AVF by using his/her fingers in circular motion to promote blood flow and decrease the risk of clot formation.

4. Cardiovascular exercises include walking, cycling, and swimming to help in improving overall cardiovascular health and promote blood flow to the fistula.

- The researchers instructed every study participant to start these exercises from the second day postoperatively, 1-5 min/session-6 sessions /day- every day/week for six weeks the patient can increase the duration and intensity of exercise gradually as tolerated and AFV healed.
- The patients were instructed to perform these exercises at home and record performance in a paper chart. The researchers follow every study participant every day by telephone call and during follow-up visits.

The Control group (2):

Patients in this group received routine hospital care and evaluated by the researchers during follow-up visits.

- All study participants were interviewed in the study setting to collect needed data, after taking permission from the hospital and departmental managers. Data collection started from December 2024 and ended in April 2025
- Every patient in study and control group was interviewed four times: initially before doing the operation, second after 2 weeks postoperative, third after 6 weeks and fourth after 10 weeks.
- During the first interview data collect using first tool. The three next interviews the researchers used second tool to assess AVF maturation. Clinical maturation was assessed by a blinded experienced researcher.

Statistical analysis:

Data was evaluated using the SPSS 21.0 (SPSS, Inc., Chicago, IL, USA) statistics program. Descriptive

statistics were used to describe demographic data. All continuous variables are used mean and standard deviation and numbers (percentages). Efficacy outcomes were presented as percentages, and P values were from Mann-Whitney test. Categorical variables between the two groups calculated by chi-square test, independent samples t-test were used. The statistical significance level was set at 0.05.

RESULTS:

Table 1: Bio-demographic characteristics and Clinical data of the study participants (n=64).

Table 1 shows similarity between the study and control groups in terms of all socio-demographic characteristics. Significance tests indicate non-significant differences in age (P= 0.211), gender (P=0.800) , education (P=0.850), marital status (P=0.740) residence area (P=0.226), occupation (P=0.370), smoking (P= 0.545), comorbidities (P= 0. 573)and body mass index (P=0.956) between the study and control groups. The mean age of the study group was 56.65±5.49, and 54.96±5.18 for the control group. More than half of study and control group were females (56.25%, 59.37%). Regarding level of education, 30.63 % of study group had preparatory and secondary education, while 43.75% of control group were higher education. The majority of both groups were married (81.25%, 84.37%). Regarding residence, 71.87% of the study group and 84.37% of the control group resided in urban areas. In terms of occupation, 43.75% of the study group and 65.62% of the control group were administrative work. In relation to smoking, a large percentage of both groups (75%, 81.25%) were nonsmoker. Concerning comorbidities, both groups were suffering from hypertension (50%), diabetes mellitus (44.11%), heart diseases (35.29%), liver diseases (20.59%) with a body mass index of 22.65±2.24.

Table 2: Comparison of AVF Clinical maturation between Study and Control group

Table 2 representing a comparison between the study and control group in relation to the clinical manifestations of arteriovenous access maturation. Significance tests indicate non-significant differences between the study and control group during the 1st assessment. Clinical significant differences were found between the study and control group during the 2nd (P=0.045) and 3rd assessment (P=0.02) in relation to distension of fistula site as shown distended in 65.56%, 100% of the study group. Flat vein status during arm elevation was present in 62.50% and 96.87% of the study group with a statistically significant differences during the 2nd (P=00.12) and 3rd assessment (P=0.027). distended AVF in Dependent position was noticed in 62.50% and 100% of the study group with a statistically significant differences during the 2nd (P=00.12) and 3rd assessment (P=0.02). No signs of infection were detected in 93.75% and 96.87% of the study group with a statistically significant differences during the 2nd (P=0.041) and 3rd assessment (P=0.027).

During palpation, firm consistency was felt in 65.63% and 87.50% of the study group with a statistical significant differences during the 2nd (P=0.039) and 3rd assessment (P=0.006). warm temperature also found in 93.75% and 96.87% of the study group with a statistical significant differences during the 2nd (P=0.041) and 3rd assessment (P=0.027). No tenderness was present in 93.75% and 96.87% of the study group with statistically significant differences during the 2nd (P=0.041) and 3rd assessment (P=0.027). presence of thrill in 93.75% and 100% of the study group

with a statistically significant differences during the 2nd (P=0.003) and 3rd assessment (P=0.026). by auscultation, bruit was found in 31.25% and 59.37% of the study group with a statistically significant differences during the 2nd (P=0.045)

Table 3: Total Comparison of AVF Clinical maturation between Study and Control group

Table 3 showed a total Comparison of AVF Clinical maturation between Study and Control group. Statistical significance differences were found during post 6 (P=0.001). After 12 weeks' assessment 100% of study group and 93.75% of control group represent full AVF clinical maturation.

Table 4: comparison of AVF Ultra Sound maturation between Study and Control group

Table 4 represents the difference between the study and control group in relation to AVF Ultrasound maturation. Significance difference was found during after 6 weeks' assessment in the cephalic vein (P=0.012) and brachial artery (P=0.025)

Table 1: Bio-demographic characteristics and Clinical data of the study participants (n=64).

	Total (n=64)		Study group (n=32)		Control group (n=32)		Test of Significance (p-values)
	No.	%	No.	%	No.	%	
Age (years)							
Mean± SD	55.81±5.36		56.65±5.49		54.96±5.18		t= 1.26 (0.211)
Gender							
Male	27	42.18	14	43.75	13	40.63	X^2= 0.06 (0.800)
Female	37	57.81	18	56.25	19	59.37	
Level of education							
Read & write	14	21.88	7	21.87	7	21.87	X^2=0.32 (0.850)
Preparatory &secondary	24	37.50	13	40.63	11	34.37	
Higher education	26.0	40.62	12	37.50	14	43.75	
Marital status							
Single	11	17.87	6	18.75	5	15.62	X^2=0.11 (0.740)
Married	53	82.81	26	81.25	27	84.37	
Residence area							
Urban	50	78.12	23	71.87	27	84.37	X^2=1.46 (0.226)
Rural	14	21.88	9	28.12	5	15.62	
Occupation							
Manual work	5	7.82	3	9.37	2	6.25	X^2=3.14 (0.370)
Housewife	10	15.62	6	18.75	4	12.50	
Administrative work	35	54.68	14	43.75	21	65.62	
Not working	14	21.88	9	28.12	5	15.62	
Smoking							
Yes	14	21.87	8	25.00	6	18.75	X^2=0.36 (0.545)
No	50	78.13	24	75.0	26	81.25	
Comorbidities							
Hypertension	17	50.00	11	61.11	6	37.50	Mc=2.09 (0.573)
Diabetes mellitus	15	44.11	7	38.88	8	50.00	
Heart disease	2	35.29	8	44.44	4	25.00	
Liver disease	7	20.59	3	16.67	4	25.00	
BMI							
Mean ± SD (weight in Kg/height in m^2)	22.65±2.24		22.64 ±2.04		22.67±2.46		t=-0.05 (0.956)

Table 2: Comparison of AVF Clinical maturation between Study and Control group

AVF Clinical maturation assessment items	Study (n=32)			Control (n=32)			Test of Significance X^2 (p-values)		
	1st	2nd	3rd	1st	2nd	3rd			
I- Inspection									
1. Distension of fistula site									
Abnormal (not distended)	17 (53.12%)	11(34.37%)	0 (0.0%)	24 (75.00%)	20 (62.50%)	5 (15.62%)	3.32≠ (0.117)	5.07 (0.045)*	5.42 (0.02)*
Normal (distended)	15 (46.87%)	21(65.62%)	32 (100.0%)	8 (25.00%)	12(37.50%)	27 (84.37%)			
2. Vein status during arm elevation									
Abnormal (Distended)	18 (56.25%)	12(37.50%)	1(3.125%)	25(78.12%)	22(68.75%)	7(21.87%)	3.47 (0.109)	6.27 (0.12)	5.14 (0.027)*
Normal (Flat)	14 (43.75%)	20(62.50%)	31(96.87%)	7(21.87%)	10(31.25%)	25(78.12%)			
3. Observe AVF in Dependent position									
Abnormal (Flat)	17(53.12%)	12(37.50%)	0 (0.0%)	24(75.00%)	22(68.75%)	5 (15.62%)	3.32	6.27	5.42
Normal (Distended)	15(75.00%)	20(62.50%)	32 (100.0%)	8(25.00%)	10(31.25%)	27 (84.37%)	(0.059)*	(0.12)	(0.02)*
4. Signs of infection									
Present	4(12.50%)	2 (6.25%)	1 (3.12%)	9(28.12%)	8 (25.00%)	7 (21.87%)	3.32	4.26	5.14
absent	28(87.50%)	30 (93.75%)	31 (96.87%)	23(71.87%)	24 (75.00%)	25(78.12%)	(0.058)*	(0.041)*	(0.027)*
II. Palpation									
1. Consistency									
Abnormal (Soft)	22 (68.75%)	11 (34.37%)	4 (12.50%)	23 (71.87%)	19 (59.37%)	14 (43.75%)	0.07	4.02	7.73
Normal (Firm)	10 (31.25%)	21 (65.63%)	28 (87.50%)	9 (28.12%)	13 (40.63%)	18 (56.25%)	(1.00)	(0.039)*	(0.006)*
2.Skin temperature									
Cold or hot	4(12.50%)	2 (6.25%)	1 (3.12%)	9(28.12%)	8 (25.00%)	7 (21.87%)	3.32	4.26	5.14
warm	28(87.50%)	30 (93.75%)	31 (96.87%)	23(71.87%)	24 (75.00%)	25(78.12%)	(0.058)*	(0.041)*	(0.027)*
3. Tenderness									
present	4(12.50%)	2 (6.25%)	1 (3.12%)	9(28.12%)	8 (25.00%)	7 (21.87%)	3.32	4.26	5.14
Absent	28(87.50%)	30 (93.75%)	31 (96.87%)	23(71.87%)	24 (75.00%)	25(78.12%)	(0.058)*	(0.041)*	(0.027)*
4.Thrill									
Absent	11 (34.37%)	2(6.25%)	0(0.00%)	16(50.00%)	12(37.50%)	5(15.62%)	0.21	9.14	5.423
Present	21(65.62%)	30 (93.75%)	32(100.00%)	16(50.00%)	20(62.50%)	27(84.38%)	(0.165)	0.003*	(0.026)*
III. Auscultation for Bruit									
absent or **faint**	11(34.37%)	2(0.33%)	0(0.0%)	16 (50.00%)	8(25.00%)	3(9.37%)	3.12 (0.333)	6.17 (0.045)*	3.065 (0.066)
soft bruit	18(56.25%)	20(62.50%)	13(40.62%)	15 (46.87%)	20(62.50%)	17(53.12%)			
louder and more continuous	3(9.37%)	10(31.25%)	19(59.37%)	1(3.125%)	4(12.50%)	12(37.50%)			

≠ Fisher exact test, X^2: Chi-Square test, level of significance $p \leq 0.05$

Table 3: Total Comparison of AVF Clinical maturation between Study and Control group

	Total (n=64)		Study group (n=32)		Control group (n=32)		Test of Significance (p-values)
	No.	%	No.	%	No.	%	
After 2 weeks							
Mild	1	1.56	1	3.12	0	0.0	X^2=6.88 (0.032)*
Moderate	28	43.75	9	28.12	19	59.37	
Full	35	54.68	22	68.75	13	40.62	
After 6 weeks							
Moderate	12	37.50	0	0.0	12	37.50	X^2=14.76 (0.001)*
Full	52	81.25	32	100.00	20	62.50	
After 10 weeks							
Moderate	2	3.12	0	0.0	2	6.25	X^2=2.06 (0.151)
Full	62	96.87	32	100.00	30	93.75	

X^2: Chi-Square test, level of significance $p \leq 0.05$

Table 4: comparison of AVF Ultra Sound maturation between Study and Control group

	Study group (n=32)	Control group (n=32)	Test of Significance	(p-values)
	Mean ± SD	Mean ± SD		
After 2 weeks				
Cephalic vein	5.02 ± 0.59	4.84 ± 0.46	t=1.39	(0.170)
Brachial artery	5.39 ± 0.42	5.21 ± 0.43	t=1.71	(0.093)
After 6 weeks				
Cephalic vein	6.14 ± 0.57	5.84 ± 0.31	t=2.61	(0.012)*
Brachial artery	6.11± 0.57	5.85 ± 0.24	t= 2.33	0.025*

t: student t test, level of significance $p \leq 0.05$

Discussion:

Arteriovenous fistula (AVF) is one of three types of vascular access that is vital for patients with chronic renal failure undergoing hemodialysis which is the most common renal replacement therapy for these patients. The arteriovenous fistula remains the access of choice for hemodialysis patients until today **(Illig et al, 2024; Tapia & Oleas, 2022).** Compared to other types of accesses, arteriovenous fistula has less complications, lower mortality rate, and longer post-operative patency rate **(Nantakool, 2020**). However, a considerable number of AVFs have risk for maturation failure **(Illig et al, 2024)**. Hence, AVF require assisted maturation by interventional procedures **(Sabiu, 2023)**. Among these interventional procedures is using post-operative exercise which is evident in improving maturation of AVF and preventing its failure **(Nantakool, 2020**).

In the present study, significant differences in clinical manifestations of arteriovenous access maturation were present in the second and third assessment where the normal distention of fistula site, during arm elevation and in dependent position as well as signs of infection were significantly observed in about one quarter better in the study than the control group. It may be related to the general effect of exercise which stimulates circulation. On the other hand, after fistula creation, blood flow from the artery to the vein generates

changes of vascular wall structure and increases shear stress that causes nitric oxide activation. nitric oxide in response caused vasodilatation. Thus, causing distention in fistula site and in dependent position while promoting venous return on arm elevation. This process increases by time to reach its maximum effect after 10 weeks. This result was agreed by **(Nantakool, 2020)** who concluded that isometric exercise training at quarter of maximum voluntary contraction provided is helpful in maturation of AVF maturation in patient with chronic kidney disease**.**

Moreover, **(Manjunath et al, 2021)** and **(Li et al, 2024)** mentioned that limb movements, with arm exercises, improve blood circulation and metabolism which also help in prevention of infection where the progress of healing process decrease risk of invasion of microorganisms on fistula site.

In addition, statistically significant differences were noticed in the second and third assessment for both groups regarding palpation and auscultation assessment items findings of AVF which were more better in the study group than in control group. It could be related to the fact that exercise promotes vascular remodeling where there is increase in capillarity within the active muscle of the affected arm as well as enlargement of the vessels, which increases the flow capacity to the arm muscle which improves the clinical maturation of the AVF that is evident by firm Consistency, warm skin temperature, no tenderness and presence of thrill and bruit. Relatively, continuing arm exercises to the eighth weeks post operatively gives the chance for continuing maturation even in patients with chronic illness and older adults. These results were congruent with **(González et al, 2021)** who stated that isometric exercises were recommended as a strategy to promote maturation which was applied with different styles in the current study.

As for total comparison of AVF Clinical maturation between study and control group, after 2 weeks' full maturation was noticed in more than two thirds of patients in the study group, while less than half of patients in the control group had full maturation. Meanwhile, after six weeks all patients in the study group and less than two thirds of patients in the control group had full AVF maturation. Thus, highlight the progressive and relatively short duration of appearance of effect of exercise program on maturation of AVF where the majority of patients in the control group had AVF maturation after 10 weeks with four weeks slower than the study group. This was concluded by **(Manjunath et al, 2021)** who illustrated that post-operative handgrip exercise program leads to an increase in the clinical maturation of radiocephalic AVF.

On the other hand, previous studies indicated that a high rate of AVF maturation is affected by lower BMI, male gender, and absence diabetes **(Siddiqui et al, 2017)** where these aspects were not significant in the current study.

As for ultrasound maturation of AVF, a significant difference was noticed after 6 weeks in the evaluation of cephalic vein and brachial artery in patients in the study than in the control groups. Thus, impower the effect of arm exercise appears not only in clinical physical examination but also appears in diagnostic evaluation. That was mentioned by **(Manjunath et al, 2021)** who concluded clinical and ultrasound maturation of AVFs after carrying out a post-operative program of isometric exercises, as compared with four weeks before exercise program where isometric exercises had increased clinical maturation of AVFs and therefore this type of exercise program should be considered for the maturation process.

Certainly, nursing role of patients with chronic renal failure became more and more detailed and developed to include items that help in rapid, safe and effective maturation of AVF side by side with conventional care. Because risk of

maturation failure is evident and needs assisted maturation by interventional procedures **(Sabiu, & Gallieni, 2023)**.

These exercises include handgrip exercise, arm exercises, fistula massage and cardiovascular exercises could be very effective in maturation of AVF which is the sole of hemodialysis the acts as fundamental procedure for patient with chronic renal failure. The nurse here is the essential personnel in assessing, implementing and evaluating patients in this program in this elegant exercise program. Not only that but also, medical-surgical rehabilitation staff are also responsible for teaching patients and family howe to perform these exercises safely and effectively, follow patient compliance and modify them if needed.

Certainly, nursing role of patients with chronic renal failure became more and more detailed and developed to include items that help in rapid, safe and effective maturation of AVF side by side with conventional care because risk of maturation failure is evident and need assisted maturation by interventional procedures.

Conclusion and recommendations:

Significant clinical maturation assessment of AVF by inspection, palpation and auscultation is earlier and more evident in the study group patients. all patients in the study group and significant ultrasonic maturation earlier than the majority of patients in the control group.

Recommendations:

- Longer follow up for these exercise long term effects on hemodialysis patients.
- Include exercise program postoperatively for patients undergoing AVF procedure in management plan.
- Enroll these exercises in the training programs, workshops and seminars for all health staff caring of patients with AVF.
- Replicate this study on larger samples and on patients with other types of hemodialysis accesses in the arm.

Declaration of Competing Interest:

The researchers declare that they have no identified competing financial interests or personal relations that could have appeared to impact the work informed in this paper.

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