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Comparative study between two different hand squeezing exercises in improving hand grip strength for patients underwent arteriovenous fistula surgery

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Abstract

Background: Patients with newly placed arteriovenous fistula are generally advised to perform hand exercise because of its effects on fistula maturation. Aim of the study was to compare between two different hand exercises in improving hand grip strength for patients underwent arteriovenous fistula surgery.

Setting: Vascular surgery department and outpatient clinics of the vascular surgery at Assiut University Hospital. Subjects 60 patients who had chronic kidney disease and had undergone arteriovenous fistula surgery for hemodialysis. After the surgery, subjects divided into two groups one group(30) used hand gripping GD grip squeezing exercise and the other one(30) used soft ball squeezing exercise. The subjects continued the exercises for 4 weeks. The hand strength of the subjects were assessed before and after the hand-squeezing exercises.

Results: Showed that 25 patients of both groups had pain of the access arm, 6 patients had abnormal sensation of the access arm and both groups had normal access arm and had thrill on palpation and bruit on auscultation.

Conclusion: The results showed that hand squeezing exercise with GD Grip was more effective in improving hand grip strength compared to hand squeezing exercise with soft ball.

Recommendations: Further research to evaluate the effect of the improved hand strength on the activities of daily living, and replication of the study using a larger probability sample acquired from different geographical areas.

Keywords: arteriovenous fistula, chronic kidney disease, hemodialysis, hand squeezing exercise, Gd grip

Introduction

Long term survival in patients with chronic renal disease on hemodialysis is related to adequate hemodialysis dosage, therefore, an adequately functioning high-flow vascular access is required. Before starting hemodialysis is created a permanent or temporary vascular access. For chronic renal patients is recommended the definitive access, since it allow adequate flow of the prescribed dialysis (Carbal *et al*., 2013 and Pessoa and Linhares, 2015) [1, 2].

Autogenously arteriovenous or AV fistula (AVF) is a type of vascular access involving a direct connection between an artery and an adjacent a vein, usually in the non-dominant hand, to limit the consequence of any functional disability. This causes venous engorgement and enlargement allowing adequate blood flow at the rate of 600 mL⁄min for hemodialysis. Therefore, AVFs are the preferred modality in view of the superior patency rates and fewer complications compared with arteriovenous synthetic grafts (Feezor and Huber, 2012 & Fermi, 2014) [3, 4].

Although this is considered as the gold standard for safe and effective vascular access during hemodialysis treatment. The fistula is susceptible to various complications such as: AVF dysfunction, venous thrombosis, edema or ischemia in the fistula-created limb, cardiac overload, blood hypo flow, aneurysm, infection atherosclerosis, and neuropathy after surgery. Success of AVF surgery depends primarily on the pre-operative condition of artery and vein. Increased arterial flow is an important aspect associated with increase in the success rate of AVF. Veins Lumina with larger diameter are associated with enhanced AVF maturation (Stolic, 2013 & Khavanin *et al*., 2012) [5, 6].

Secondary an appropriate vascular maturation time is needed after surgery to avoid these complications. Different maturation times ranging from 4 to 8 weeks were suggested. (Tonia *et al*., 2013) [7]. Fistula maturation require fundamental care for maintenance of AVF, on the part of health professional and patients, which need to orient one about hand squeezing exercises in the management of its newly vascular access. Hand-squeezing exercise with a soft ball is usually performed after the AVF surgery. It suggests that the patients should perform hand squeezing exercise 2 days when edema of the limb has decreased. The surgical site should be checked by the surgeon and the patient must stop the exercise, if there are any unusual findings at the surgical site, such as sustained edema, redness, tenderness, and discharge or abscess formation.

Exercise is thought to increase the rate of fistula maturation. It hypothesized that exercises increase the blood flow and hence, the diameter of the out flow vein. Therefore, repetitive exercise tends to dilate the vein, increase AVF function, reduce AVF related morbidity and mortality in adults on HD (Padilla *et al*., 2011) [8].

Significance of the study

AVF failure to mature remains a barrier to its successful usage for HD treatment. Few studies have demonstrated the beneficial effects of hand exercise on maturation of the fistula and reduction in the complications after AVF surgery. Hand exercise was proved to be effective in maturation of the fistula. Also, it could consequently decrease the mortality rate after AVF surgery. Inspite of no study has assessed which type of hand exercise is more effective for improving the hand strength after AVF surgery. Hence, this study conducted to compare between two different hand exercises in improving hand grip strength for patients underwent arteriovenous fistula surgery.

Aim of the study

To compare between two different hand exercises in improving hand grip strength for patients underwent arteriovenous fistula surgery.

Research questions

1. Which type of hand squeezing exercises are more beneficial for improving the hand grip strength after AVF surgery?
2. Is there any significant difference between the two types of hand squeezing exercises in improving the hand gripstrength?

Subjects and method

Research design

Comparative research design was utilized in this study

Setting

Vascular surgery department and outpatient clinics of the vascular surgery at Assiut University Hospital.

Subjects

The study included 60 adult patients who were diagnosed with chronic kidney disease and had undergone arteriovenous fistula surgery for hemodialysis at Assiut University Hospital. Subjects divided into two groups (one group used GD grip squeezing exercise and the other one used soft ball squeezing exercise).

Exclusion criteria

- If patients had injury, history of surgery, or limitation of motion (LOM) in the fistula-created limb `
- Patients with peripheral neuropathy or radiculopathy
- Rheumatic disorders, myopathy, and any type of arthritis.

Fig 1: GD grip

Fig 2: Soft ball

Tools

Tool I: Vascular access patient's assessment sheet: This tool consists of three parts:

Part 1: Sociodemographic patient characteristics: this part was used to assess patient's name, age, gender, level of education, occupation**,** date of surgery and date of follow up.

Part 2: Medical data: this part included

- **Causes of chronic renal failure**: this included diabetes, hypertension, renal calculi, glomerulonephritis, pyelonephritis, Systemic lupus erythematous, Polycystic kidneys, Long term amino glycoside therapy and unknown causes.

Part 3: vascular access's assessment: this part included the following items:

A. subjective data: (Pain of the access arm, Abnormal sensation of the access arm)

B. Objective data: it included the following items.

- **Inspecting the access arm for:** Color change accompanied by engorgement of superficial veins**,** Pallor, cyanosis, normal skin, hematoma, sustained edema, redness, tenderness, discharge and abscess formation.
- **Palpation of the access arm fo**r: Thrill, change of temperature, Change in capillary refill.
- **Auscultation of the access arm for**: The bruit

Tool II: Suggested measure for hand grip strength (GST -2013)

This suggested tool used for evaluate hand grip strength for patients with arteriovenous fistula after hand squeezing exercise.it was a portable electronic scale (fig 3) specification40kg /20g,was modified by made metal hanger, stainless steel frame 12×25 cm length, metallic hanger and two metallic bar, upper and lower bar and cover this two bare by two pieces of sponge covered by a piece of cloth folding and covering the bar, portable electronic scale standby mode at zero, patients were encouraged to catching the two bar by her fist and press hard as they could and

repeat this three times and the researcher registered three reading.

Fig 3: grip strength test GST-2013

grip strength test GST-2013

Hand Squeezing Exercise program

It developed by researchers based on the content of the best practice statement for hand squeezing exercises (it included hand squeezing exercise by using GD grip and soft ball. Group of patient used GD grip and the other used soft ball.

Method

The study was conducted through

- Data were collected at vascular surgery department and outpatient clinics of the vascular surgery at Assiut University Hospital during the period from May 2018 to October 2018.
- An official permission was obtained from the head of Assiut University Hospital to conduct the study.
- The study tools and hand squeezing exercises program were formulated after a review of the literature.
- The content validity was done by 5 expertise in the field of medical surgical nursing field and medical field.
- A pilot study was conducted on 10 patients of the subjects to examine easiness and clarity of the tools; those patients were included in the main study as no modifications were done.
- Patient's agreement for voluntary participation was obtained after the purpose and nature of the study were explained.
- Data were assured confidentiality and anonymity and were collected using the pre-mentioned study tools.
- The study was carried out during the morning and afternoon shift
- The patients were randomly allocated into two groups, and the first group (30 subjects) used handgrip for the hand-squeezing exercise, and the second group (30 subjects) used soft ball.
- the researcher met with each patient before operation
- The researchers met the selected patients Base line data were collected using tool I. (part 1 and 2) and measured hand grip strength using tool II
- the researcher met with each patient after operation to educate patients hand squeezing exercise for one session
- The subjects who used GD Grip set their handgrip resistance at 10 repetition maximum (RM), and performed 10 squeezes for 1 set. They performed 3 sets of 10 squeezes each at a 1-minute interval. Three sets of exercises were performed 2 times in the morning and 2 times in the afternoon.
- The subjects who used Soft Ball squeezed the ball 10 times for 1 set, and performed 3 sets of 10 squeezes each at an 1-minute rest interval. Three sets of exercises were performed twice in the morning and twice in the afternoon
- Each session took about 30- minutes a day
- During the session each patient was given soft ball or GD grip according to his group for manipulating exercise
- the researcher met the patient after 10 days in outpatient clinics of the vascular surgery to assess vascular access tool I(part 3)
- After one month the researcher met the patient in outpatient clinics of the vascular surgery to evaluate the patients' hand grip strength using tool II

Ethical considerations

- Research proposal was approved from Ethical Committee in the Faculty of Nursing.
- There was no risk for study subject during application of the research.
- The study followed common ethical principles in clinical research.
- Study subject had the right to refuse to participate and or withdraw from the study without any rational at any time.
- Study subject privacy was considered during collection of data.

Results

Table 1: Distribution of the studied sample regarding Sociodemographic characteristics (no=60)

Socio Demographic data	GD Grip(n=30)		Soft ball(n=30)		P. value
	N.	%	N.	%	
Age					
• 20-30	6	20.0	6	20.0	0.678
• 31-40	4	13.3	7	23.3	
• 41<50	2	6.7	3	10.0	
• 51-60	18	60.0	14	46.7	
Mean ±SD	44.20±13.37		41.73±13.10		0.473
Sex					
• Male	16	53.3	12	40.0	0.301
• Female	14	46.7	18	60.0	
Education					
• Red and write	25	83.3	22	73.3	0.199
• Primary education	1	3.3	4	13.3	
• Secondary education	4	13.3	2	6.7	
• University	0	0.0	2	6.7	
Occupation					
• Professional	7	23.3	3	10.0	0.308
• Manual	2	6.7	4	13.3	
• Not working	21	70.0	23	76.7	
Marital status					
• Single	2	6.7	5	16.7	0.421
• Married	28	93.3	25	83.3	
• Divorced	0	0.0	0	0.0	

Chi-square test

Table (1) showed that the mean ages of patients in the groups using GD grip and soft ball were 44.20±13.37 years and 41.73±13.10 years, respectively. Regarding sex (53.3%) of GD grip group was male and (60%) of soft ball group was female. Regarding education, occupation, marital status; it was found that the highest percentages in both groups were red and write, not working and married. There was no statistically difference in the age, sex, education, occupation and marital status between two groups.

Table 2: Distribution of the studied sample regarding to medical data

Causes of chronic renal failure	GD Grip(n=30)		Soft ball(n=30)		P. value
	N.	%	N.	%	
Diabetes					
• Yes	10	33.3	5	16.7	0.136
• No	20	66.7	25	83.3	
Hypertension					
• Yes	26	86.7	21	70.0	0.117
• No	4	13.3	9	30.0	
Glomerulonephritis					
• No	30	100.0	30	100.0	-
Pyelonephritis					
• No	30	100.0	30	100.0	-
polycystic Kidneys					
• Yes	0	0.0	2	6.7	0.150
• No	30	100.0	28	93.3	
Renal calculi					
• Yes	2	6.7	8	26.7	0.038*
• No	28	93.3	22	73.3	
Systemic Lupus erythematous					
• Yes	1	3.3	2	6.7	0.554
• No	29	96.7	28	93.3	
Long term amino glycoside therapy					
• No	30	100.0	30	100.0	-
Unknown cause					
• Yes	4	13.3	4	13.3	1.000
• No	26	86.7	26	86.7	

Chi-square test, * Significant difference at p. value<0.05

Table (2) revealed that 47 patients of both groups had chronic renal failure due to hypertension, 15 patients had CRF due to diabetes, 10 patients had CRF due to renal calculi, 3 patients had CRF due to systemic lupus erythematous, 8 patients had CRF due to unknown cause.

Table 3: Vascular access assessment for GD grip group and soft ball group

Vascular access assessment	GD Grip				Soft ball				P. value
	Present		Absent		Present		Absent		
	N.	%	No	%	N.	%	No	%	
Subjective data									
• Pain of the access arm	9	30.0	21	70.0	16	53.4	14	46.6	0.115
• Abnormal sensation of the access arm	2	6.7	28	93.3	4	13.3	26	86.7	0.389
Objective data: Inspecting the access arm for									
• Color change accompanied by engorgement of superficial veins	0	0.0	30	100.0	0	0.0	30	100.0	-
• Pallor	0	0.0	30	100.0	0	0.0	30	100.0	-
• Cyanosis	0	0.0	30	100.0	0	0.0	30	100.0	-
• Normal	30	100.0	0	0.0	30	100.0	0	0.0	-
• Hematoma	2	6.7	28	93.3	4	13.3	26	86.7	0.671
• Sustained edema	4	13.4	26	86.6	0	0.0	30	100.0	0.112
• Redness	2	6.7	28	93.3	0	0.0	30	100.0	0.492
• Tenderness	0	0.0	30	100.0	0	0.0	30	100.0	-
• Discharge	0	0.0	30	100.0	0	0.0	30	100.0	-
• Abscess formation, or bleeding from incision	0	0.0	30	100.0	0	0.0	30	100.0	-
Palpation of the access arm for									
• Thrill	30	100.0	0	0.0	30	100.0	0	0.0	-
• Change of temperature	0	0.0	30	100.0	2	6.7	28	93.3	0.150
• Change in capillary refill	0	0.0	30	100.0	0	0.0	30	100.0	-
Auscultation of the access arm for									

• The bruit	30	100.0	0	0.0	30	100.0	0	0.0	-

Chi-square test,*Significant difference at p. value<0.05,**Significant difference at p. value<0.01

Table (3) demonstrated that 25 patients of both groups had pain of the access arm, 6 patients had abnormal sensation of the access arm and both groups had normal access arm and had thrill on palpation and bruit on auscultation.

Table 4: Comparison of hand grip strength before and after exercise between GD grip and soft ball groups

Two Different Hand Exercises	Before exercise			After exercise		
	GD Grip	Soft ball	P. value	GD Grip	Soft ball	P. value
Mean ±SD	5.58±4.16	4.7±2.37	0.614	10.66±4.41	5.23±2.36	<0.001**
Median(IQ)	3.54(2.88-5.56)	3.5(2.89-6.33)		9.50(8.50-11.65)	4.00(3.00-7.00)	

Mann-Whitney test **statistically significant difference at P. value <0.01

Table (4) there was highly significant difference pre and post exercise between GD grip and soft ball groups with p value <0.001. exercise with GD grip exercise significantly improved hand grip strength with mean 10.66±4.41 compared to soft ball exercise with mean 5.23±2.36.

Statistical analysis

Numerical data were explored for normality by checking the distribution of data and using tests of normality (Kolmogorov-Smirnov and Shapiro-Wilk tests). Age data showed normal (parametric) distribution. While Two Different Hand Exercises data showed non-normal (non-parametric) distribution. Data were presented as mean, median, standard deviation (SD) and range values.

For parametric data; independent t-test was used to compare between in the two groups. For non-parametric data; Mann-Whitney U test was used to compare between the two groups. Qualitative data were presented as frequencies and percentages. Chi-square test (or Fisher's Exact test when applicable) were used for comparisons regarding qualitative data. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM SPSS Statistics Version 20 for Windows.

Discussion

With regard to Sociodemographic data the current study results revealed that three fifths of the patients in the GD grip group and more than two fifths in the soft ball group were ranged between 51-60 year of age group and a minimum of patient in both group belong to age group between 41<50years. This finding is supported by the results achieved by Sabouhi *et al*., (2013) [9] who found that the subjects' mean age in the present study was over 50 years, with more than half of GD grip group were male but in soft ball group three fifths of patients were female. This was on contrary with Mohammed, (2010) [10] who pointed that more than three fifths of the sample (80 patient divided into study group and control group 40 for each group) were male in the study group, while in the control group were three quarter. Also Nasiri *et al*., (2011) [11] concluded that the higher number of male subjects of chronic renal failure prevalence seem to be more prevalent among men.

In relation to marital status, the findings of this study indicated that the highest percentages in both groups were married. Similar to Ahmed, (2011) [13] who found that the majority of patients were married. As well, Mohammed, (2010) [10] who found that the majority of the study group were married while three quarter in the control group.

Regarding to occupation, results of this study revealed that the highest percentages in both groups not working, this is agreed with Clementino *et al*., (2018) [12] who found that vast majority were un employed.

According to medical data, the present study revealed that majority of patients of both groups had chronic renal failure(CRF)due to hypertension, one third of patients had CRF due to diabetes, which is inconsistent with the findings of the study done by Mohamed, (2014) [14] who found that the most prevalent etiology of the chronic renal failure was chronic glomerulonephritis in more than half in the experimental group and more than three fifths in the control group and hypertension more than one fifth in both groups. Our results agreed with the results of the study done by Sesso *et al*., (2016) [16] who found that the main diagnoses related to primary renal disease were systemic hypertension (HTN) and diabetes mellitus (DM), followed by chronic glomerulonephritis and polycystic kidneys.

According to vascular access assessment, the results of the present study illustrated that there were changes in access arm as pain, and abnormal sensation. On the other hand, it was observed that all patients had normal access color, presence of bruit sound, and palpable a thrill in both groups. This was in agreement with Naushad, (2013) [15] who found that proper nursing management including access arm exercises, elevation and applying measures that prevent compression on nerves and blood vessels, improve access arm blood supply and venous return.

With regard to hand grip strength between GD grip and soft ball groups before and after exercise. Our study shows that there was highly significant difference pre and post exercise between GD grip and soft ball groups with p value <0.001. These study in line with the study of Kong *et al*., (2014) [17] who revealed that although exercise with Soft Ball improved the strength of the index finger and thumb flexors, it could not increase the hand grip strength. On the other hand, it was observed that exercise with GD Grip significantly improved all the 3 types of pinch and grip strength. We hypothesized that the hand-squeezing exercise with GD grip are more beneficial for improving the hand grip strength after AVF surgery, and the hand-squeezing exercise with GD grip cause a statistically significant increase in the grip strength (p=0.001). it may bb attributed to performing exercise with increased resistance (GD grip) caused more protein synthesis in the muscle and increased total volumes of muscle than training with same resistance (soft ball).

Limitations of the study

- The research findings were limited and cannot be

generalized because of the small sample size and it a was selected from one geographical area in Egypt.

Conclusion

Exercise with GD Grip significantly improved the strength of the hand compared with exercise with Soft Ball.

Recommendations

- Further research to evaluate the effect of the improved hand strength on the activities of daily living.
- Replication of the study using a lager probability sample acquired from different geographical areas.

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