Measuring pinch strength before and after haemodialysis session in patients with end stage renal failure

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Abstract

The objective of the study was to observe the change in Pinch Strength (PS) of arteriovenous fistula (AVF) arm and non-AVF arm before and after haemodialysis (HD). A total of 31 patients (21 Male and 10 Female) undergoing HD during January and February 2020 at a trust hospital were selected through purposive sampling. Mean PS was calculated from the measurements taken using the Jamar digital pinch gauge with an interval of five seconds between each measurement. Paired sample T-test was applied using SPSS 20. The mean PS values for AVF arm when compared before and after the session were 3.64 ±1.01 and 2.87 ±1.20 kgs ($p<0.01$), whereas for non AVF arm PS values were 3.96 ±1.50 and 3.69 ±1.37 kgs ($p=0.09$). It was concluded that PS of AVF arm decreased more significantly after HD as compared to the non AVF arm.

Keywords: Pinch strength, Haemodialysis, Arteriovenous fistula, Musculoskeletal.

DOI: https://doi.org/10.47391/JPMA.1406

Introduction

Haemodialysis is an essential treatment for chronic renal failure (CRF) and, depending upon its severity, the patient is advised dialysis twice or thrice times a week. Complete and efficient removal of waste, salt, and extra water during a dialysis session requires at least 250-300ml of blood in the connection[1] thus moving almost a pint of blood in and out of the body each minute.[2] For this purpose, an arteriovenous fistula (AVF) is introduced surgically. AVF is a large connection made between the artery and the vein of the body usually in the patient's arm. The large diameter of AVF allows an adequate amount of blood to flow through the dialyzer, ensuring complete and efficient removal of waste products.[2]

Although a safe and reliable option, the AVF does have its limitations, primarily leading to musculoskeletal disorders. In patients with chronic kidney disease muscle biopsies have shown Type II muscle atrophy. Biochemical analysis shows a deficit of mitochondrial energy resources.[3,4] Patients undergoing haemodialysis are quite prone to developing sarcopenia and muscle wasting.[5] In order to understand such changes, Hand Grip Strength (HGS) has been used as an important measure for the diagnosis of muscle wasting and weakness.[6]

Hand grip strength (HGS), the maximal voluntary force applied by the hand is described as a useful, inexpensive, and non-invasive tool for measuring grip force.[6] An important drawback of HGS measurements is that the patient has to record measurements while standing, with both arms extended on sides, which becomes difficult and uncomfortable for frail patients.[5] To overcome this problem, Pinch Strength (PS) is now being used as a convenient method of measurement. Pinch Strength (PS), like HGS, is inexpensive and non-invasive but is also comfortable for both the patients and the researcher. HGS and PS mainly target similar muscle groups; therefore, PS can be used as an alternative method.[5]

The primary aim of the study was to observe the change in pinch strength in both the AVF arm as well as in the non-AVF arm after the haemodialysis session, as the AVF can be the cause of altered PS leading to decreased muscle strength. The study was done to measure the changes in PS of haemodialysis patients by comparing the pre- and post-dialysis values of both the AVF and non-AVF arms.

Patients and Methods

After ethical approval from the review board of University of Lahore, a cross-section study design was chosen for this research. A purposive sampling technique was used to select 31 patients undergoing haemodialysis at University of Lahore Teaching Hospital, Lahore (trust hospital) during the months of January and February 2020. Sample size was calculated by using the online calculation tool called Epitool.[7] Confidence level (95%), desired precision (± 5%) and population size as used in previous research[8] were used as the parameters for

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sample size calculation. A total of 31 patients were selected (21 males and 10 females). The patients underwent haemodialysis twice a week for 3.5 hours to 4.5 hours. Informed signed consent was taken from the patients after explaining the benefits of the study. Anyone with a history of arm fracture, dementia, and bleeding disorders was excluded from the study. Patients included in the study were from the dialysis centre of University of Lahore Teaching Hospital, Lahore.

Patients were weighed before the measurement and were then asked to lie on their beds in a supine position. The pinch strength of both hands was measured using "Jamar Pinch Strength Gauge" irrespective of the dominant hand and the readings were taken in pounds (lbs). The measurement was performed three times with 5-second interval for each measurement.[9]

After the dialysis session the patients were allowed to take a 5 minutes break to prevent any chance of bleeding from the needle entry points. The PS was then again measured three times with an interval of 5 seconds between each measurement. Mean value for the pre- and post-dialysis readings of both AV fistula arm and non-AV fistula arm were then used for data analysis.

Readings were taken in the same conditions for pre- and post-haemodialysis session with the patient lying in supine position and the wrist in neutral position. PS of the AV fistula arm was measured first, followed by the non-AV fistula arm.

Frequency tables and charts were developed for sociodemographic data. Paired sample T-test was applied to the pre- and post-dialysis PS mean of each hand to determine any change. The statistical significance was considered as $p<0.05$. All the data analysis was done using the SPSS 20 (SPSS, Inc., Chicago, IL, USA).

Results

The data for pinch grip was collected from 30 patients with the mean age of 50.94 ± 16.3 years and minimum and maximum age of 23 and 76 years, respectively, as one patient dropped out of the study during measurements due to low blood pressure making the patient opt out of the research. The data collected was in pounds (lbs) and was later converted into SI units (kgs) after the measurements and are presented as kgs in the results.

The mean age was comparable in both the male and female patients (male 52.66 ±13.10) and (female 47.27 ±16.08) with the mean pinch strength before and after the haemodialysis higher in males [8.518lbs (3.863kgs ± 2.83) and ± 6.543lbs (2.96kgs) (SD=2.65)] as compared to females [7.074lbs (3.20kgs ± 2.71) and 5.91lbs ± 2.86 kgs) (SD=2.62)] in AVF arm. The same trend was observed in the non-AVF arm as mean pinch value for male participants [9.238lbs (4.190kgs ± 3.31) and ± 8.29lbs (3.760kgs ± 3.03)] before and after the haemodialysis session was greater than female participants [7.75lbs (3.515kgs ± 3.28) and ± 7.86lbs (3.56kgs) (SD=3.3)]

The mean value for Pinch strength of the AV fistula arm and the non-AV fistula arm before and after the haemodialysis session and the T-test results are described in Table.

Discussion

Pinch strength and hand grip strength were two measures compared by the earlier researches.[10] These studies were mostly done after the haemodialysis session and thus lacked the comparative analysis of the effect that haemodialysis (AVF) can have on the overall muscle strength. Al Katab et al[5] in their study only measured the pinch strength in haemodialysis patients once. This did not show the effect of haemodialysis and AVF on the muscle strength. Thus, leaving a gap to observe the change in pinch strength that was caused by the haemodialysis session[5].

Patients receiving haemodialysis treatment usually avoid using the limb with AV fistula which can lead to impaired functioning.[11] Patients with AVF usually are in fear and as a result of non-usage of the AVF arm, the overall musculoskeletal system is weakened, which is evident through the decreased pinch strength of the AVF arm. Similarly, the range of the upper limb may be limited due to the presence of surgically introduced AV fistula in the arm,[11] which results in decreased muscle strength of the upper limb especially in the AV fistula arm which was

Table: Paired sample T-test on AVF arm and non AVF arm.

	AVF Arm					Non-AVF Arm				
	Mean AV pre HD	Mean AV post HD	Difference Post-Pre	Standard deviation (T-test)	P Value for T- test (AVF arm)	Mean AV pre HD	Mean AV post HD	Difference Post-Pre	Standard deviation (T-test)	P Value for T- test (non-AVF arm)
lbs.	8.0369	6.3322	1.70467	1.38336	p<0.01	8.7444	8.1489	.59556	1.16134	p=0.09
SI unit Kgs	3.64	2.87	0.454			3.96	3.695	0.26		

AV= arteriovenous, AVF arm= arteriovenous fistula, HD= haemodialysis, non-AVF arm= non arteriovenous fistula arm, lbs=pounds, kg=Kilograms.

observed in the current study.

Many different studies have been conducted regarding hand grip strength but the amount of literature for pinch strength is very limited and, therefore, a lot of future research is needed on this subject. On the other side, the dominant and non-dominant hand grip strength has been discussed very scarcely in the literature. However, research done by C. A. Armstrong suggest that there is no significant difference among the dominant and non-dominant arms when measuring strength.[10]

Although there was a significant difference in the AVF arm and a non-significant difference in the non AVF arm, it is very difficult to determine the actual cause behind the decrease in pinch strength after haemodialysis. Plausible explanations for this can be due to the pain experienced by the patient after haemodialysis, fear of bleeding from the AVF arm, generalised weakness experienced by the patient after the haemodialysis session or due to the protective response from the patient. One of the objectives of the study was to investigate the effect of haemodialysis on the generalised muscle strength as it corresponds with the general health status of the patients which was reduced as indicated by the decrease in their Pinch Strength. This is the first step towards research that involves advising strengthening exercises and physical therapy modalities and to see if they can help against this decline in pinch strength.[12]

The results derived from the study provide an insight that more still needs to be done for haemodialysis patients. Primarily, the musculoskeletal decline can be maintained by proper physical therapy sessions.

Conclusion

There is a statistically significant decrease in pinch strength after the haemodialysis session in the AVF arm which shows that AVF may lead to decreased muscle strength with the risk of muscle atrophy over time, resulting in the loss of functional movements and activities of daily living (ADLs). Concluding from the given evidence, it can be said that the hypothesis mentioned in the article proved right as AVF did have an impact on Pinch Strength.

Acknowledgement: We would like to acknowledge the efforts, support and guidance that of Dr Asim Arif, PT provided to us throughout the duration of the study. Also special thanks to Mr Kamran Hanif for his expert contributions in bio statistical work.

Disclaimer: None to Declare.

Conflict of Interest: None to Declare.

Funding Disclosure: None to Declare.

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