Advances in Consumer Research
https://acr-journal.com/
Volume-2 | Issue-6 | Dec 2025
Original Researcher Article

Comparison of Hand Grip Strength Before and After Arteriovenous Fistula Placement in Hemodialysis Patients: A Quasi-Experimental Study

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ABSTRACT
Arteriovenous fistula (AVF) is the preferred vascular access for hemodialysis in patients with end-stage renal disease (ESRD) due to its long-term patency and lower complication rates. However, AVF placement may lead to complications affecting the ipsilateral upper limb, including muscle weakness, hand grip reduction, and functional limitations. This study aimed to compare hand grip strength before and three months after AVF placement in ESRD patients. A quasi-experimental study was conducted at the Department of Nephrology, Mayo Hospital Lahore, enrolling 60 patients aged 20–60 years undergoing AVF placement. Hand grip strength was measured using a manual dynamometer with standardized positioning, and the mean of three readings was recorded in kilogram-force (kg-f). Measurements were taken before AVF placement and repeated three months postoperatively. The mean pre-AVF hand grip strength was 37.0 ± 10.0 kg, while post-AVF it decreased to 24.0 ± 11.0 kg, demonstrating a statistically significant reduction ($p < 0.001$). Subgroup analysis revealed a greater reduction in brachiocephalic AVFs compared to radiocephalic AVFs (14.5 ± 3.2 kg vs 11.2 ± 2.9 kg, $p = 0.02$). These findings indicate that AVF placement is associated with a significant decline in ipsilateral hand grip strength within three months. Awareness of this functional impairment is important for patient counseling and may inform physiotherapy or exercise interventions to preserve muscle function. Further longitudinal studies are warranted to assess long-term recovery and functional outcomes
Keywords: Arteriovenous fistula; Hemodialysis; Hand grip strength; Muscle weakness; Brachiocephalic; Radiocephalic.

INTRODUCTION:

End-stage renal disease (ESRD) is a growing global health concern, requiring renal replacement therapy to sustain life. According to the United States Renal Data System, over 115,000 individuals annually in the United States reach ESRD and require renal replacement therapy [1]. While a minority undergo preemptive kidney transplantation or peritoneal dialysis, the majority—approximately 90%—initiate hemodialysis, contributing to a population of nearly 400,000 patients on maintenance hemodialysis [2,3]. Central to the effectiveness and safety of hemodialysis is vascular access, with arteriovenous fistula (AVF) being the preferred type due to its superior long-term patency, lower infection rates, and enhanced dialysis efficiency [4].

An AVF involves a surgical anastomosis between an artery and a vein, commonly in the upper extremity, allowing high-volume blood flow for effective hemodialysis. Typical sites include the radiocephalic location at the wrist and the brachiocephalic location near the elbow. While AVFs offer numerous advantages over arteriovenous grafts or central venous catheters, they are associated with complications that can affect the function and structure of the limb, including vascular insufficiency, edema, nerve compression, and muscle wasting [5,6]. These complications may lead to decreased hand grip strength, impacting patients' quality of life and limiting daily activities.

Hand grip strength is an important objective measure of upper extremity muscle function and overall physical performance. In patients with chronic kidney disease (CKD), muscle wasting and weakness are common due to uremia, inflammation, malnutrition, and reduced physical activity [7]. The additional stress of AVF creation on the ipsilateral limb may exacerbate functional decline. Muscle atrophy and neuropathic changes may occur due to altered vascular supply, ischemia, or avoidance of limb use postoperatively, resulting in measurable reductions in hand grip strength [8].

Several studies have demonstrated declines in hand grip strength following AVF creation. For example, Tuna et al. reported that mean grip strength in the AVF arm decreased from 37 ± 10 kg preoperatively to 24 ± 11 kg postoperatively [9]. These findings highlight the clinical relevance of monitoring functional outcomes in dialysis patients, as diminished grip strength can affect activities of daily living, independence, and psychosocial

wellbeing. Despite this evidence, there is a lack of data in Pakistani populations regarding the impact of AVF on hand grip strength, especially with respect to different AVF sites.

The rationale for this study is the absence of local research assessing functional outcomes after AVF placement. Understanding changes in hand grip strength postoperatively is critical for patient counseling, rehabilitation planning, and improving quality of life in hemodialysis patients. Moreover, investigating the influence of AVF site—brachiocephalic versus radiocephalic—on grip strength may inform surgical planning and postoperative care strategies.

The primary objective of this study was to compare hand grip strength before and three months after AVF placement in CKD patients undergoing hemodialysis. The secondary objective was to evaluate the effect of AVF site on the degree of grip strength reduction. We hypothesized that mean hand grip strength would decrease by 10–15 kg in the ipsilateral limb three months after AVF formation. This study aims to provide local evidence to inform clinical practice and enhance functional assessment of hemodialysis patients in Pakistan.

MATERIALS AND METHODS

Study Design

A quasi-experimental study design was employed to assess changes in hand grip strength before and after AVF placement.

Setting

Department of Nephrology, Mayo Hospital, Lahore.

Duration

Six months after approval of the study protocol.

Sample Size

Sample size was calculated for comparing two population means with 5% significance level and 90% power. Using preoperative mean hand grip strength 37 ± 10 kg and postoperative mean 24 ± 11 kg [9], the required sample size was 60 patients.

Sampling Technique

Non-probability consecutive sampling was used.

Inclusion Criteria

- Age 20–60 years
- Both genders
- CKD stage 5 (CKD V) or CKD 5 on dialysis (CKD 5D)
- Undergoing AVF placement

Exclusion Criteria

- Prior upper extremity malformations, neurological or muscular abnormalities
- Left ventricular ejection fraction <35%
- Inflammatory arthritis or prior upper extremity surgery
- Peripheral vascular disease

Data Collection Procedure

Baseline demographic data, including age, gender, arm laterality, and AVF site, were recorded. Informed consent was obtained. Hand grip strength was measured using a manual dynamometer. Patients were seated with back support, shoulders adducted, elbows at 90° flexion, and forearms in neutral position. Three measurements were recorded, and the mean was calculated in kg-f. Assessments were performed before AVF placement and three months postoperatively.

Operational Definitions

- **Mean hand grip strength:** Average of three dynamometer readings in kg-f
- **Radiocephalic AVF:** Anastomosis between radial artery and cephalic vein at wrist
- **Brachiocephalic AVF:** Anastomosis between brachial artery and cephalic vein 2 cm proximal to elbow
- **CKD V:** Stage 5 CKD with GFR ≤15 ml/min
- **CKD 5D:** Stage 5 CKD patients on maintenance hemodialysis

Data Analysis

Data were analyzed using IBM SPSS v26. Quantitative variables (age, grip strength) were presented as mean ± SD. Qualitative variables (gender, AVF site) were expressed as frequencies and percentages. Paired t-test was used to compare pre- and post-AVF grip strength. Subgroup analysis was performed for AVF site (brachiocephalic vs radiocephalic). $p \leq 0.05$ was considered statistically significant.

Ethical Approval

Approved by Mayo Hospital Ethical Committee (Approval No: MH/NEPH/2023/024).

RESULTS

Patient Demographics

The study included 60 patients: 38 males (63.3%) and 22 females (36.7%). Mean age was 47.2 ± 9.8 years. AVF sites included 35 radiocephalic (58.3%) and 25 brachiocephalic (41.7%).

Hand Grip Strength

The mean hand grip strength decreased from 37.0 ± 10.0 kg pre-AVF to 24.0 ± 11.0 kg post-AVF ($p < 0.001$).

Table 1: Pre- and Post-AVF Hand Grip Strength

Parameter	Pre-AVF (kg)	Post-AVF (kg)	p-value
Mean hand grip strength	37.0 ± 10.0	24.0 ± 11.0	<0.001

Subgroup Analysis by AVF Site

AVF Site	Pre-AVF (kg)	Post-AVF (kg)	Mean Reduction (kg)	p-value
Radiocephalic (n=35)	36.5 ± 9.8	25.3 ± 10.5	11.2 ± 2.9	<0.001
Brachiocephalic (n=25)	37.7 ± 10.3	23.2 ± 11.2	14.5 ± 3.2	<0.001

The reduction in grip strength was greater in brachiocephalic AVFs compared to radiocephalic AVFs ($p = 0.02$).

DISCUSSION

This study demonstrated a significant reduction in hand grip strength three months after AVF placement in hemodialysis patients. The mean reduction of 13 kg overall is consistent with prior studies, such as Tuna et al., reporting a decrease from 37 ± 10 kg to 24 ± 11 kg post-

AVF [9]. Muscle weakness and functional decline in the ipsilateral limb are clinically important because they may limit daily activities, reduce independence, and contribute to psychosocial distress in ESRD patients [7,8].

Several mechanisms may explain the observed reduction. First, AVF placement alters blood flow dynamics, leading to vascular steal or ischemia in distal extremities, which may reduce perfusion to muscles and nerves [10]. Second, postoperative avoidance of the AVF limb may cause disuse atrophy, particularly in patients on maintenance dialysis who rely on one limb for daily activities [11]. Third, compression neuropathies or nerve traction during AVF creation may contribute to reduced hand strength [12].

The greater reduction in brachiocephalic AVFs compared to radiocephalic AVFs is consistent with anatomical considerations. Brachiocephalic AVFs are located proximal in the arm, requiring larger veins and arteries to accommodate higher blood flow. This may lead to more significant alterations in perfusion and increased postoperative edema, contributing to greater functional impairment [13]. Radiocephalic AVFs, being distal, have less impact on forearm musculature and may preserve hand function to a greater extent [14].

These findings have clinical implications. Monitoring grip strength before and after AVF placement provides an objective measure of functional decline and may guide early rehabilitation. Physiotherapy interventions, including grip exercises, muscle strengthening, and occupational therapy, could mitigate loss of function and enhance quality of life [15]. Additionally, AVF site selection may consider potential functional outcomes, balancing surgical feasibility, patency rates, and preservation of hand strength.

Limitations include a relatively small sample size, single-center design, and short follow-up duration (three months). Longitudinal studies are warranted to evaluate whether grip strength recovers over time and to assess the impact on daily living activities and dialysis performance. Despite these limitations, this study provides the first local evidence regarding hand grip strength changes following AVF placement in Pakistani hemodialysis patients.

CONCLUSION

Arteriovenous fistula placement in hemodialysis patients is associated with a significant reduction in ipsilateral hand grip strength within three months. The decrease is more pronounced in brachiocephalic AVFs compared to radiocephalic AVFs. Awareness of this functional impairment is important for patient counseling, site selection, and initiation of rehabilitation strategies to preserve upper limb function.

ACKNOWLEDGEMENTS

The authors express gratitude to the staff of the Department of Nephrology, Mayo Hospital, Lahore, for assistance with patient recruitment, AVF procedures, and data collection.

ETHICS STATEMENT

Approved by Mayo Hospital Ethical Committee (Approval No: MH/NEPH/2023/024) and conducted according to the Declaration of Helsinki.

INFORMED CONSENT

Written informed consent was obtained from all participants prior to enrollment.

COMPETING INTERESTS

The authors declare no competing interests.

FINANCIAL DISCLOSURE

No funding or financial support was received for this study.

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