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Presentation and management of limb dysfunction after native hemodialysis arteriovenous fistula

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ABSTRACT

Limb dysfunction following fistula creation can range from simple temporary finger numbness to even frank gangrene necessitating amputation. The etiologies of limb dysfunction related to native arteriovenous fistula (AVF) include venous hypertension, steal syndrome, symptomatic aneurysm, carpal tunnel syndrome, painful shoulder, ischemic monomelic neuropathy (IMN), and temporary neuropathy. A retrospective analysis of data was collected over four years (from January 2017 till May 2021) of 1709 patients who presented with vascular access-related complaints 176 of them had limb dysfunction after native hemodialysis arteriovenous fistula. All patients were assessed by history and physical exam, while investigations were done according to provisional diagnosis. The patient's information, management, and results were documented. The shortened disabilities of the arm, shoulder, and hand questionnaire (QuickDASH) was used in all included patients to assess the degree of disability. The most common cause of limb dysfunction was venous hypertension (27.04 %), followed by steal syndrome 26.7 %, symptomatic aneurysm 25.56 %, and carpal tunnel syndrome 7.95 %. The mean age of patients with the painful shoulder was higher than other etiologies, while the patients with venous hypertension were the youngest, with more females in the group. Patients with IMN and steal syndrome had the highest QuickDASH score and suffered the most intense pain of all participants. The surgical intervention was done in 133 patients. AVF preserving interventions relieved symptoms in 68.57 % of cases less than AVF sacrificing interventions which were effective in 83.07 % of cases, and the difference was statistically significant (p-value = 0.00072). We had one case of hand loss, two cases of fingertip loss, and one patient died after revascularization for steal syndrome. Limb dysfunction after native hemodialysis arteriovenous fistula is a common problem. AVF preserving intervention had a success rate and should be used in most cases before closing the AVF.

1. INTRODUCTION

Hemodialysis arteriovenous fistula (AVF) construction and complications account for about 30% of hospital visits in patients with chronic renal failure [1]. Limb dysfunction following fistula creation can range from

simple temporary finger numbness to even frank gangrene necessitating amputation [2], [3]. The etiologies of limb dysfunction related to native arteriovenous fistula include:

1- Venous hypertension: can lead to edema, pigmentation, induration, dermatosclerosis, and ulceration. Previous central venous catheters are the principal culprit, so avoiding them is the best preventive strategy [4]. Treatment options include: a- A minimal to moderate symptom could be accepted in patients with few access alternatives; b- Endovascular: angioplasty and stenting of stenosed outflow vein; c- Open surgical management: bypass and interposition grafts; d- Conversion of the side-to-side configuration to end-to-side by ligation of the distal outflow vein; and e- Closure of AVF [5].

2- Steal syndrome: hand or finger pain caused by the hypoperfusion of the hand distal to the AVF. Risk factors for steal syndrome include diabetes mellitus, smoking, female gender, proximal AVF, peripheral vascular disease, prior AVF in the same limb, and old age. The diagnosis is clinical with signs and symptoms of pain, duskiness, coolness, paresthesias, paralysis, pallor, decreased oxygen saturation, decreased or absent radial pulse. In advanced cases, there may be digital ulceration or gangrene. It is classified into three stages according to severity. Digital blood pressures, duplex ultrasonography, and transcutaneous oxygen saturation can help in the diagnosis [6], [7]. Mild cases are treated conservatively by keeping the hand warm. More severe cases may need surgery and the surgical options are: a- Distal revascularizations–interval ligation (DRIL); b- Revision using distal inflow (RUDI); c- Proximalization of arterial inflow (PAI); d- Flow-limiting procedures like banding by suturing, prosthetic wraps, or by Minimally Invasive Limited Ligation Endoluminal assisted Revision (MILLER procedure); e- Distal radial artery ligation (DRAL); and f- Closure of AVF [8], [9].

3- Symptomatic aneurysm: Aneurysm and pseudoaneurysm are common complications of AVF, while most of them are asymptomatic; some may produce symptoms of pain and limitation of movement by stretching the skin and surrounding tissues. Rarely they may have compressive neuropathy [10]. The treatment modalities are: Aneurysmorraphy; Closure of AVF; and Endovascular techniques: covered stent or stent graft [11].

4- Carpal Tunnel Syndrome (CTS): The association between carpal tunnel syndrome and dialysis is reported in the literature since more than 45 years ago [12]. The pain often worsens during dialysis. Risk factors include Diabetes Mellitus, uremia, beta-2 microglobulin deposition, and the presence of AVF. The diagnosis is clinical, but nerve conduction studies can be used to confirm the diagnosis. Ultrasound examination may be helpful in the assessment and can be an alternative to electrodiagnostic studies in hemodialysis patients [13]. Treatment depends on the severity and may include rest, surgical decompression, or ligation of the AVF [14].

5- Painful shoulder: Factors that are associated or contribute to shoulder pain in patients who have hemodialysis arteriovenous fistula include: b2-microglobulin level; CRP serum levels; Inactivity; Immobilization; muscle hypotrophy; and limited use of the upper limb [15].

6- Ischemic Monomelic Neuropathy (IMN): occurs immediately after AVF creation and is postulated to be caused by infarction of the vasa nervosa. It involves all three forearm nerves manifesting as pain, weakness, and sensory changes. AVF should be closed immediately to increase the chance of nerve recovery. [16].

7- Neuropathy due to soft tissue swelling or hematomas following surgery compressing on nerves. Usually resolves within one month [2].

2. Methods

A retrospective analysis of data was collected over four years (from January 2017 till May 2021) of 1709 patients who presented with vascular access-related complaints 176 of them had limb dysfunction after native hemodialysis arteriovenous fistula. Electronic Medical Record (EMR) of a vascular surgeon clinic in the city of Najaf/Iraq was used for data registry after taking the patient's consent. The inclusion criteria were any

patients who complained of limb dysfunction after the creation of hemodialysis arteriovenous fistula. All patients with a previous limb disability like hemiplegia, carpal tunnel syndrome, or traumatic injury were excluded. All patients were assessed by history and physical exam while duplex ultrasonography, CT-angiography, conventional angiography, electrodiagnostic studies, and other investigation were done according to provisional diagnosis. The patient's information like age, the extent of dialysis duration, gender, access configuration, management, and results were documented. The shortened disabilities of the arm, shoulder, and hand questionnaire (QuickDASH) was used in all included patients to assess the degree of disability [17]. SPSS version 22 (Chicago, US) was used for statistical analysis. P-value <0.05 was considered significant.

3. Results

The most common cause of limb dysfunction in our series was venous hypertension (30.11 %) (figure 1). The most common configuration of arteriovenous fistula in the presented patients was brachiocephalic side to side, followed by a brachiocephalic end to side (figure 3). The surgical intervention was done in 133 patients (75.56 %). The types of interventions and their success are summarized in Figures (4) and (5). The intervention was regarded as successful when it decreases the QuicDASH score by more than 20 points. Our goals in management were to relieve the symptoms and to preserve the access. AVF preserving interventions relieved symptoms in 68.57% of cases less than AVF sacrificing interventions which were effective in 83.07 % of patients, and the difference was statistically significant (p-value = 0.00072).

Table (1) The pain scale, Quick DASH scores, the mean age, and percentage of females according to the etiology.

Etiology	Pain 0–10, (mean)	Quick DASH 0–100, (mean)	Age (mean)	Females (%)
Temporary neuropathy	2.1 ±1.5	15.4 ±5.4	51.22± 19.77	50
Carpal tunnel syndrome	4.6± 2.4	26.8 ±10.3	51.71 ±11.54	57.1
IMN	5.9 ±2.3	69.6±10.5	59.8 ±7.2	40
Steal syndrome	4.8± 3.2	66.7±19.1	57.93 ±14.13	42.55
Venous hypertension	1.2± 0.7	51.8±18.6	47.38 ±18.62	66.1
Painfull shoulder	3.6± 1.4	37.2±14	64.66 ±8.35	50

Symptomatic aneurysm	4.2 ±2.6	46.9±17	46.5±15.4	55.6

4. Discussion

The higher prevalence of venous hypertension in our study may be attributed to a longer catheter time associated with a higher duration of dialysis in our patients compared to another study [3]. Ulnar nerve entrapment (cubital and ulnar tunnels), although reported previously in hemodialysis patients, is not reported in our series, and this may be an underdiagnosis of this entity [18]. The mean age of patients with the painful shoulder was higher than other etiologies, while the patients with venous hypertension were youngest, with more females in the group. Patients with IMN and steal syndrome had the highest QuickDASH score and suffered the most intense pain of all participants (Table 1).

Our policy is the adoption of end to side technique in all patients, and even after side-to-side configuration, we ligate the distal vein. Most of the side-to-side cases were done in other centers. The side-to-side configuration, although is easier to do but is associated with relatively higher complications [19]. Banding of 10 high flow AVF with steal syndrome resulted in only 60 % success rate compared to 79 % success rate in another series of patients done by [20]. In cases with rupture of infected AVF aneurysms, Brachial artery ligation without reconstruction was proven to be a safe option in an emergency [21]. We used this approach even in a less emergent situation to minimize operative risk and complication, especially in fragile patients who are less likely to need hand strength. The procedure is done under local anesthesia with a mean operative time of 20.04 ± 7.34 minutes, significantly lower than the mean operative time needed for reconstruction 73.67 ± 16.4 minutes (p-value is less than 0.0001). There was no significant difference in postoperative mean QuickDASH score between the two groups (10.67 ±3.2 versus 8.45 ±2.9 p-value = 0.099), but we had 2 cases that developed ischemia that needed revascularization. We had one amputation of the gangrenous hand caused by steal syndrome in a patient who refused AVF closure despite all efforts to convince him. In addition to two cases of gangrenous fingertip amputation also caused by steal after late AVF closure. The mortality rate in our intervention group was 0.75 %, much less than reported in other series included only patients with steal syndrome who are older and have more advanced comorbidities. Another reason to lower mortality is less use of advanced techniques like DRIL and RUDI [22].

Conservative treatment was chosen in 43 patients. Most of the cases were of stage one steal syndrome and venous hypertension; most of them had improvement of symptoms with time and non-operative treatments. We lost follow-up in 10 patients.

5. Conclusions

Limb dysfunction after native hemodialysis arteriovenous fistula is a common problem. AVF preserving intervention had a success rate and should be used in most cases before closing the AVF. We were limited by minimal use of general or regional anesthesia because of our patient's operative risks and the need for the facility. Although it greatly hindered us from choosing more complex AVF preserving techniques, it significantly decreased mortality in our series. Another limitation was the small role of the novel endovascular methods in management.

6. Ethics approval and consent to participate

Before enrollment, written informed consent was obtained from the patients or their parents/guardians of minors for those below 18 years. The study was conducted according to the ethical standards established by

the 1964 Declaration of Helsinki.

Competing interests
The authors declare that they have no competing interests

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Authors' contributions
BA: data collection, interventions, and drafted the manuscript. WA: data collection and interventions. Both authors: study design, statistical analysis, read and approved the final manuscript.

List of abbreviations
AVF = Arteriovenous fistula; IMN = Ischemic monomelic neuropathy; QuickDASH = The shortened disabilities of the arm, shoulder, and hand questionnaire; SPSS = Statistical Package for the social science; DRIL = Distal revascularizations–interval ligation; RUDI = Revision using distal inflow; PAI = Proximalization of arterial inflow; MILLER = Minimally Invasive Limited Ligation Endoluminal assisted Revision; DRAL = Distal radial artery ligation; CTS = Carpal Tunnel Syndrome; CRP = C-reactive protein level; EMR = Electronic Medical Record; SD = Standard Deviation

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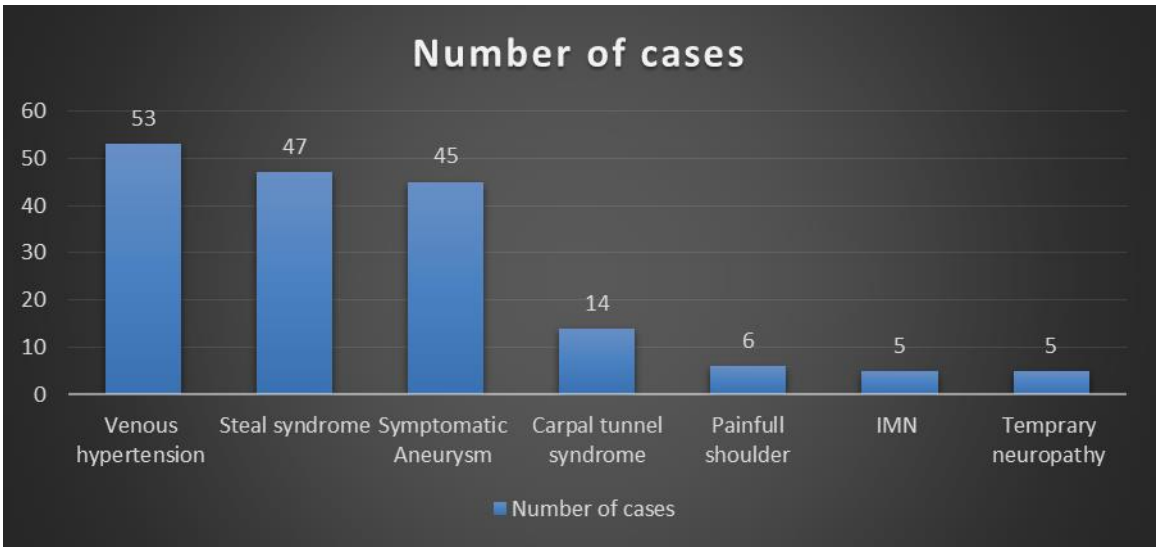

Figure (1) The etiology of limb dysfunction and number of cases

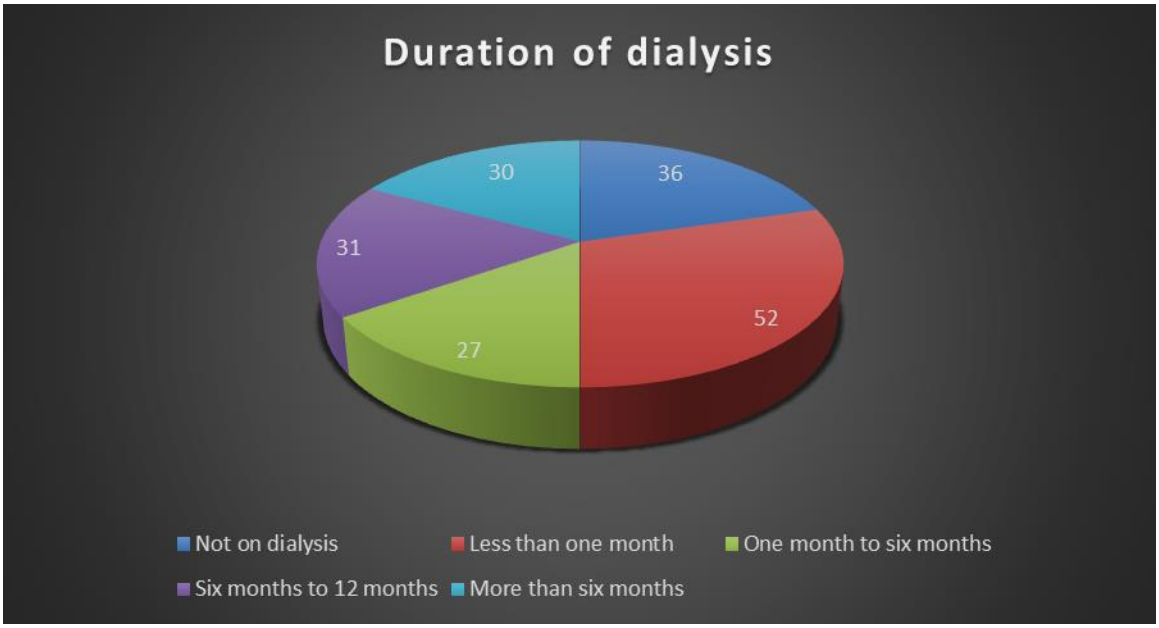

Figure (2) The duration of dialysis in our patients

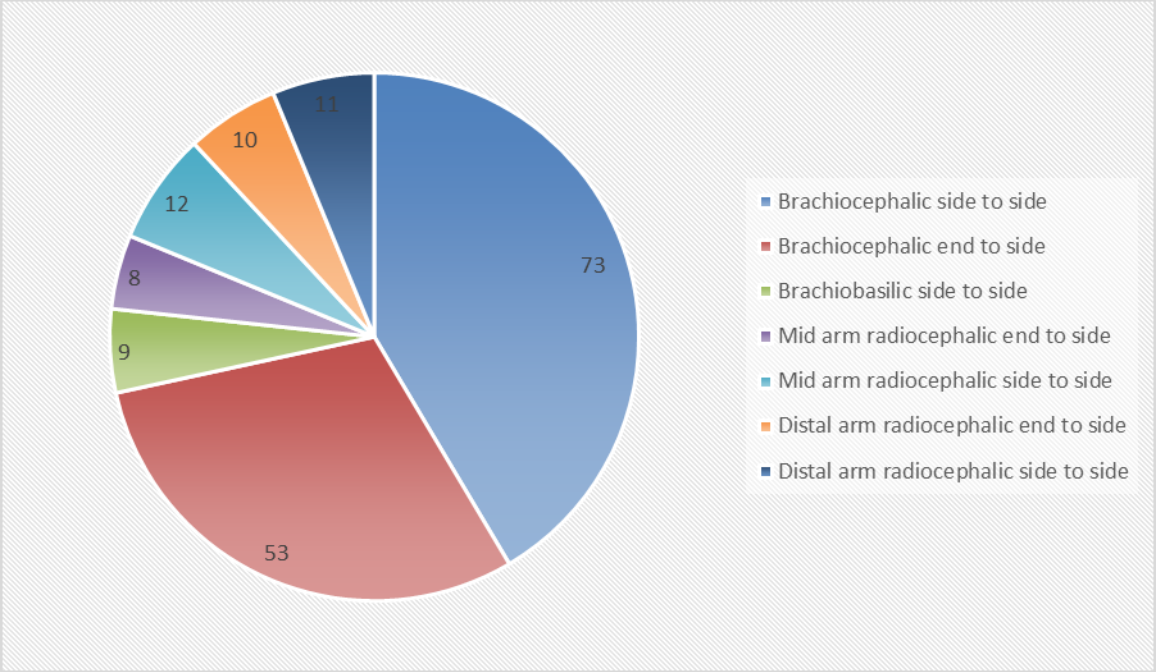

Figure (3) The AVF configuration

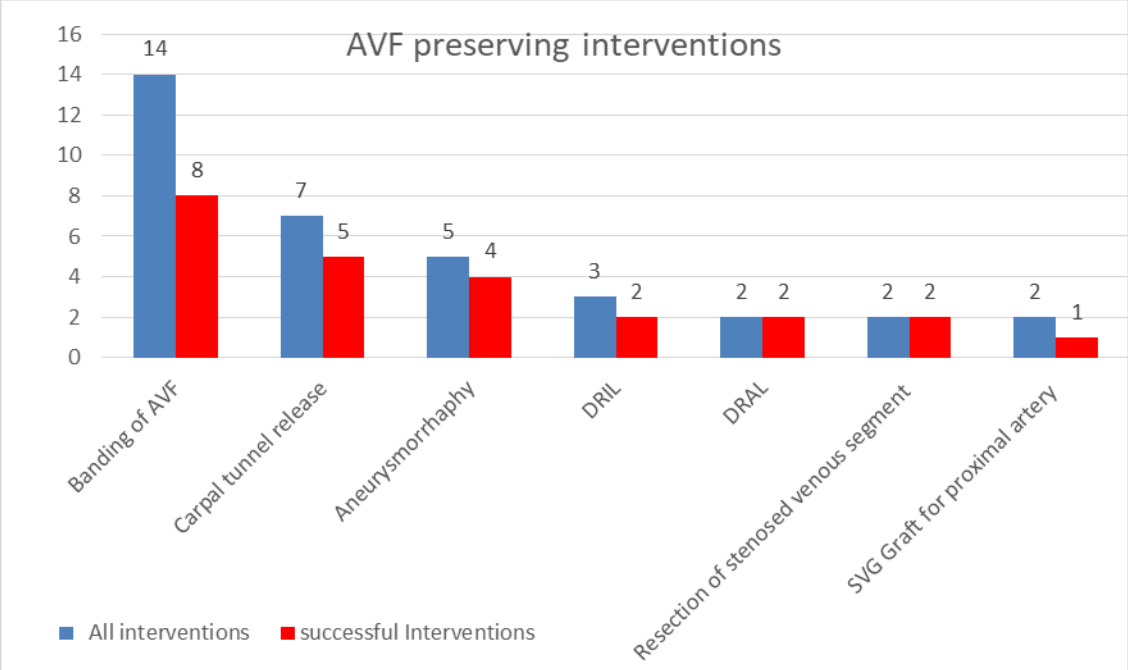

Figure (4) AVF preserving interventions

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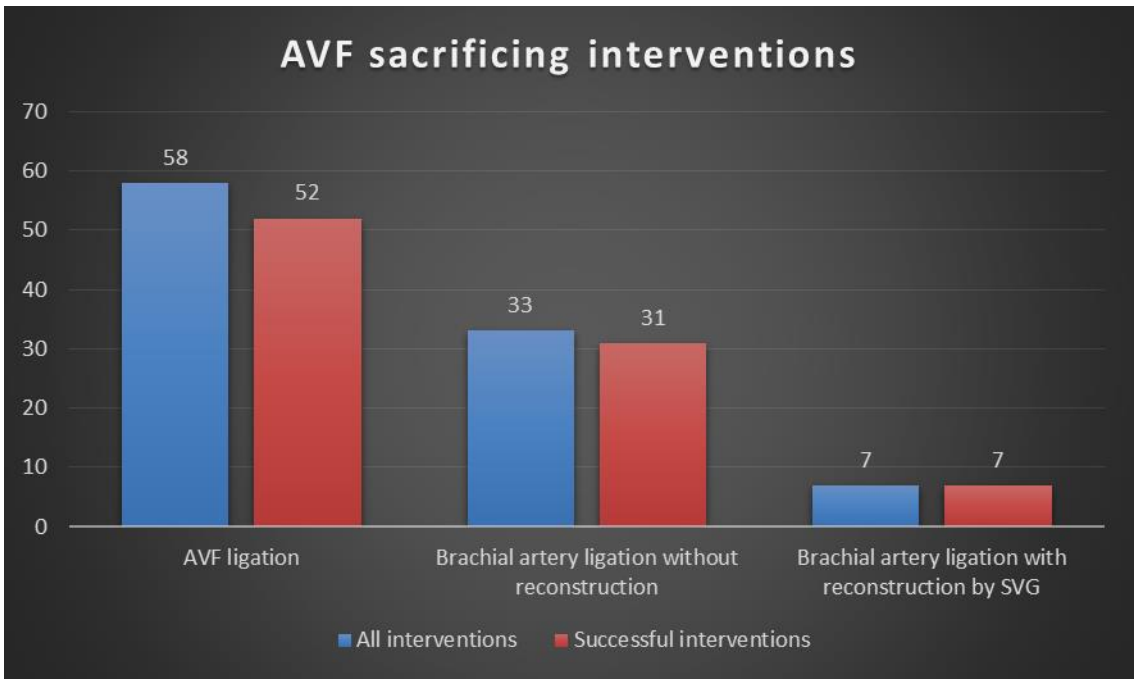

Figure (5) AVF sacrificing interventions