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Survey Method of Vascular Surgery on the Onset of Ischemic Steal Syndrome Following Vascular Access in Dialysis Patients

Seyed Masood Mousavi [1], Iraj Nazari [2] and Rahim Chanany [1,*]
[1]Department of Surgery, Imam Khomeini Hospital, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran
[2]Department of Vascular Surgery, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran

[*]*Corresponding author*: Department of Surgery, Imam Khomeini Hospital, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran. Email: rahim.chanany@gmail.com

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Abstract

Background: Access to arteries is one of the most appropriate approaches for helping chronic kidney diseases.
Objectives: The aim of the present study was to evaluate the survey method of vascular surgery on the onset of ischemic limb syndrome following vascular access in dialysis patients.
Methods: In this cross-sectional study, the population study was patients with end-stage renal disease (ESRD) referring to Ahvaz Golestan Hospital in 2018. Control of limbs temperature and comparison with the other side, before and after surgery, feeling cold by the patient, control of organs pulse and comparison with the other side, pain of organs comparing to the other side, pain during the dialysis, paresthesia, and movement failure and during dialysis, and organs atrophy-ulcer were measured.
Results: In the present study, 294 patients, including 139 women (46.94%) and 156 men (53.06%), were studied. Ischemic steal syndrome (ISS) was observed in 20 patients, that 13 cases of them had benefited from fistula approach and 7 patients used graft approach. The most common observed ISS was related to brachiocephalic fistula approach (AVF-Brachiocephalic) and then graft in arm. In non-steal syndrome group, brachiocephalic fistula (AVF-Brachiocephalic) had the most common application. In the present study, there was no significant correlation between access method and underlying diseases of high blood pressure, diabetes, and cardiac ischemic diseases.
Conclusions: One of the most important results of the present study was the highest existence of steal syndrome in brachiocephalic approach, which is confirmed by other studies.

Keywords: Steal Syndrome, Renal Dialysis, Hemodialysis, Vascular Access, Fistula, Transplants

1. Background

Nowadays, the living continuation of thousands of patients with chronic or acute renal failure is debtor of hemodialysis, and their numbers are increasing every day (1). The first step in dialysis is to provide an appropriate vascular availability, which is achieved with the embedding of a catheter in the central venal system in acute cases and with creation of a fistula and an arterial graft in chronic cases (2, 3).

At the end of 2016, the number of dialysis patients was estimated 2,989,000 individuals around the world. Of these, about 89% are under treatment with hemodialysis method, and the rest are treated with peritoneal dialysis (4, 5). With regards to the 6% growth of numbers of hemodialysis patients, which is progressed alongside with growth of end-stage renal disease (ESRD) patients (5-6%), it is expected that this therapeutic method remains still the most important treatment method of ESRD patients (6, 7). Also, 24,000 people with ESRD live in Iran, and survival rate after 10 years was 0.05 (8). Vascular access for dialysis is considered the Achilles heel of chronic dialysis patients, and arterial-vascular fistula and graft are also the best accessibility methods for dialysis (9). According to the recommendation of the American Association for Vascular Surgery (AAVS), the application of vein of the patient to dialysis arterial accessibility leads to an obvious decrease in mortality and morbidity among the patients (10). According to this recommendation, the first choice is radiocephalic fistula in wrist area; however, there are no appropriate arteries in this area in most patients; therefore, the next choice is brachycephalic fistula in antecubital area (11). The choice artery for creation of fistula is commonly radial or brachial arteries. Another selection is the application of bypass graft, which can be performed more commonly at arm and lower limbs region and lesser commonly at thorax area (12). More commonly, embedding of vascular-arterial graft and lesser commonly vascular-arterial fistula can lead to decreasing of perfusion of distal parts, which leads to creation of arterial blood flow shunt (steal phenomenon), which is also called dialysis access-associated steal syndrome (DASS) (13). The steal

phenomenon can be observed on average in one-fourth of patients receiving vascular accessibility, which needs intervention in 4% of cases with severe manifestations (14). The arterial steal phenomenon can be appeared immediately to years after embedding of arterial-vascular accessibility with ischemic signs such as sense decrease, paresthesia, or weakness (15). Diagnostic methods include physical examination with or without access site pressure, color Doppler ultrasound, photoplethysmography, digital pulse oximetry, and the absence or presence of a distal pulse in the artery at the anastomosis site (16, 17).

2. Objectives

The aim of the present study was to evaluate the survey method of vascular surgery on the onset of ischemic limb syndrome following vascular access in dialysis patients.

3. Methods

3.1. Study Design

In this cross-sectional study, the population study was patients with ESRD referring to the vascular surgery clinic of Ahvaz Golestan Hospital in 2018. This study was conducted according to the Helsinki Declaration of Ethics for research on human subjects and after obtaining permission from the Ethics Committee of Jundishapur University of Medical Sciences, Ahvaz (IR.AJUMS.REC.1397.077).

3.2. Inclusion Criteria

End-stage renal disease (ESRD) dialysis patients who were candidates of arterial vascular accessibility for the first time were included in the study.

3.3. Exclusion Criteria

Patients with a previous history of embedding arterial-vascular accessibility and patients with a history of Heart Failure (HF) were excluded from the study. Patients had to be free of organs ischemia as ulcers, weak pulse, and predominant coldness of organs.

3.4. Procedure

Patients with ESRD who had the inclusion criteria were candidates of Access (AVG or AVF) were included in the study with history taking (age, gender, history of concurrent diseases), performing physical examinations, and comparing the two sides (organs temperature, pulse, sensory signs such as tingling, motor signs, atrophy, ulcer, pulse oximetry, bilateral blood pressure). If patients had no appropriate vein for AVF, they became candidates of AVG, and if there was no possibility of wrist fistula creation, the patient was candidate for creation of elbow fold fistula. AVF from distal to proximal was tried that is means radiocephalic after brachiocephalic and Brachiobasilic and graft of arm higher limbs.

Control of limbs temperature and comparison with the other side, before and after surgery, feeling cold by the patient, control of organs pulse and comparison with the other side, pain of organs comparing to the other side, pain during the dialysis, paresthesia, and movement failure and during dialysis, and organs atrophy-ulcer were measured.

3.5. Sample Size

According to the calculation of Cohen's d, and literature review, the minimum sample size was estimated at 150 patients. Cohen's d is usually used for statistical estimating sample sizes (18, 19).

3.6. Data Analysis

All analyses were performed using SPSS software version 20. Frequency rate and percentage were used to data description in qualitative variables, and mean, and standard deviation (middle and medieval range) are used in quantitative variables. Variance analysis (Kruskal-Wallis if needed) was used for data analysis.

4. Results

In the present study, 294 patients, including 139 women (46.94%) and 156 men (53.06%), were studied. The average age of women in this study was 55.60 $\pm$ 16.66 years, and the average age of men was 52.92 $\pm$ 16.09 years (Table 1).

Table 1. Underlying Diseases in All Patients

Type of Complication	Yes, No. (%)	No, No. (%)	P Value
HTN	149 (50.5)	145(49.2)	0.38
DM	86 (29.3)	208(70.7)	
IHD	42 (14.3)	252(85.7)	

Abbreviations: HTN, hypertension; DM, diabetes mellitus; IHD, ischemic heart disease.

Approximately half of the patients had high blood pressure; on the other hand, hypothyroidism was observed in three patients, rheumatoid in three patients, lupus in two patients, and minor thalassemia in one patient. Among the patients, two individuals had renal graft, and five patients had a history of coronary artery bypass graft CABG. Of 294 accesses to arteries, 198 cases were performed by fistula and 96 cases by grafts, among which the most

common type of embedded fistula was brachiocephalic (AVF-Brachiocephalic), and the most common graft was graft in arm (Table 2).

Table 2. Methods of Access to Arteries in All Patients

Method of Access to Arteries	No. (%)
Fistula	
AVF-brachiocephalic	139 (47.3)
AVF-radiocephalic	44 (15)
AVF-brachiobasilic	15 (5.1)
Graft	
Forearm	2 (0.7)
Arm	89 (30.3)
Lower limbs	5 (1.7)

Abbreviation: AVF, Arteriovenous fistula.

In the present study, following access to arteries, steal syndrome was observed in 20 patients that 13 cases of them had benefited from fistula approach and seven patients used graft approach. With regards to this point, total numbers of patients with embedded fistula were 198 patients; therefore, the incidence rate of steal syndrome in fistula approach was 7.07% and on the other hand, for graft approach with regards to the number of total patients with embedded grafts was 96 patients; therefore, the incidence rate of steal syndrome was 6.25% which showed the possibility of incidence of steal syndrome was higher in fistula approach; however, this difference was not significant (P = 0.76) (Table 3).

The most common observed steal syndrome was related to brachiocephalic fistula approach (AVF-Brachiocephalic) and then graft in arm. In non-steal syndrome group, brachiocephalic fistula (AVF-Brachiocephalic) had the most common application. In the present study, there was no significant correlation between access method and underlying diseases of high blood pressure, diabetes, and cardiac ischemic diseases (P = 0.96) (Table 4). To improve the status of 20 patients with steal syndrome, angioplasty with balloon was performed on five cases, four cases with Dril, four cases underwent ligation, and seven bandings were done.

5. Discussion

The steal syndrome is a common phenomenon after venous, arterial fistula surgery, and artificial graft is that the distal flow artery is reduced to the site of vascular anastomosis, and most of the blood flow is directed through the anastomosis into the venous system or artificial graft. The prevalence of Coronary Subclavian Steal Syndrome seems to be negligible at first glance; however, studies indicated it is raising as a result of the elevated number of the patients who are receiving CABG, and it reached 0.2-6.8% in CABG patients. Kudlaty et al. (2016) showed in their study that the average age of patients with steal syndrome was higher than patients without this syndrome, but there was no significant difference between the two groups for age (14), which is consistent with our results. The percentage rate of incidence of steal syndrome was about 13% in our study that was higher than the study of Kudlaty et al. (2016) that was approximately 5.6%. On the other hand, the incidence rate of this syndrome was 6.4% and 5.6% in our and their study, respectively, which are near each other (14). However, Stolic et al. showed that the average age of patients with steal syndrome was significantly higher compared to patients without this syndrome (20); however, this study also has not reported a significant correlation for age between the two groups.

The results of the present study showed that nearly half of patients had high blood pressure. Also, high blood pressure and diabetes mellitus were the most common underlying diseases in both groups; however, there was no significant difference shown between underlying diseases and occurrence of steal syndrome. Unlike the present study, there was no significant difference observed between the two groups (with and without steal syndrome) for incidence of diabetes mellitus in cardiovascular diseases in Stolic et al. study. They showed that the incidence of diabetes and cardiovascular diseases is significantly higher in steal syndrome group. In another study, Gupta et al. showed that hypertension and cardiovascular diseases rates are significantly higher in steal syndrome group; their results were not consistent with ours, but these authors also reported that both groups are not different in diabetes incidence and their results are in parallel with ours (20). However, no significant difference was observed in Kudlaty et al. study (2016) in both groups for diabetes and high pressure.

Brachiocephalic fistula (AVF-Brachiocephalic) had the most application between the fistula approaches in steal syndrome-free group. Steal syndrome was observed more common in fistula approach compared to graft, among which brachiocephalic (AVF-Brachiocephalic) and brachiobaslic fistula had the most cases, and radiobaslic showed no cases, in graft approach, the most common case was related to arm graft and steal syndrome was not observed in forearm, and lower limbs approaches. Mickley (2008) showed that the incidence rate of steal syndrome has been 16-36% in femoral graft approach in autogeny and allogeneic conditions (17).

In the study of Leake et al. (2014), the artery accessibil-

Table 3. Method of Access to Arteries in Patients with and Without Steal Syndrome Separately

Method of Access to Arteries	Patients with Syndrome, No. (%)	Patients Without Syndrome, No. (%)	P Value
Fistula			0.76
AVF-brachiocephalic	10 (50)	127 (46.9)	
AVF-radiocephalic	0 (0)	43 (15.9)	
AVF-brachiobasilic	3 (15)	12 (4.4)	
Graft			0.08
Forearm	0 (0)	2 (0.7)	
Arm	7 (35)	82 (30.1)	
Lower limbs	0 (0)	5 (1.8)	

Abbreviation: AVF, Arteriovenous fistula.

Table 4. Methods of Vascular Access in Dialysis Patients at the Onset of Ischemic Steal Syndrome

	HTN	DM	IHD	P Value
AVF-brachiocephalic, No. (%)	4 (10)	2 (10)	2 (10)	0.96
AVF-brachiobasilic, No. (%)	0 (3)	0 (3)	0 (3)	
Arm graft, No. (%)	4 (7)	1(7)	1 (7)	

Abbreviations: HTN, hypertension; DM, diabetes mellitus; IHD, ischemic heart disease.

ity rate of fistula was higher than graft, they also indicated that brachiocephalic fistula has the most application in access to arteries (21). These results were in agreement with ours. In another study, Van Hoek et al. (2006) reported that they had the most approach via radiocephalic approach. Moreover, they described the forearm graft that has been used as the major graft in their study (19). Their results were not consistent with our results. Gupta et al. showed that more than 50% of access to arteries were done via brachiocephalic fistula (22). Their study was consistent with ours. In Loh et al. study, 27 patients from 28 cases had arterial access by brachiocephalic approach, and graft was used only in one case (23), which indicates high application of this approach for arterial access in patients.

Debus and Grundmann (2017) evaluated methods of arterial approach in hemodialysis patients. Their results showed that radiocephalic fistula, brachiocephalic fistula, and basilica-brachial vein fistula were the most preferred arterial access methods in hemodialysis patients. Commencing hemodialysis with arterial-vascular fistula showed a significant decrease in mortality compared to arterial-vascular graft (24).

In Gupta et al. study, ligation, banding, and Dril had the most application in management and control of steal syndrome, respectively; however, patients showed in the follow up that the application of banding to manage the syndrome had the least benefit compared to other ways and the best method is Dril. In another study, Leake evaluated various methods in patients with severe clinical signs and indicated that Dril method led to better recovery of signs with fistula maintenance and had no complications, and they suggested Dril as the preferred method (21). It seems that selection of these measurements depends on the surgery team's opinion and various conditions of patients and the differences in studies might be because of this reason. Kudlaty et al. (2016) showed the mean age of patients with steal syndrome was higher than patients without this syndrome; however, the difference was not significant (14). This study was parallel to our results. The percentage rate of incidence of steal syndrome was about 13% in our study that was higher than the study of Kudlaty et al. that was approximately 5.6%; on the other hand, the incidence rate of this syndrome was 6.4% and 5.6% in ours and theirs, respectively that are close to each other (14). However, Stolic et al. indicated the mean age of patients with steal syndrome was significantly higher compared to patients without this syndrome (20), but this study was not significant for the correlation. This study showed that nearly half of the patients had high blood pressure; on the other hand, there was hypothyroidism in three patients, rheumatoid in three patients, lupus in two patients, and minor thalassemia in one patient. Also, high blood pressure and diabetes mellitus were the most common underlying diseases in both groups; however, Stolic et al. indicated the incidence of diabetes mellitus and cardiovascular diseases was significantly higher in steal syndrome

group (20).

5.1. Limitation

This study has some limitations, one of these was few of sample size, and the other was the follow-up of these patients.

One of the most important results of the present study is the highest existence of steal syndrome in brachiocephalic approach, which is confirmed by other studies, and this point can be extracted from the results of the present study that there may be no significant correlation between the type of approach leading to steal syndrome and underlying diseases such as blood pressure. and diabetes. Since steal syndrome may occur in short to long periods of time; therefore, long-time follow-ups are needed in future studies.

Footnotes

Authors' Contribution: All authors contributed to this study equally.

Conflict of Interests: None declared.

Ethical Approval: This study was conducted according to the Helsinki Declaration of Ethics for research on human subjects and after obtaining permission from the Ethics Committee of Jundishapur University of Medical Sciences, Ahvaz (IR.AJUMS.REC.1397.077).

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