Comparison of Distal Arterial Hemodynamic Changes of the Upper Extremity Loop and Straight Arteriovenous Grafts

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Abstract- Hemodialysis access has been considered as a support for end-stage renal patients. We measured the hemodynamic changes of the distal part of the upper extremity immediately after providing the AVGs in each method mentioned above and then compared the results. This method is a novel one and hasn't been used in any other studies before. We studied 32 patients referred to the vascular surgery department of Rasht Razi Hospital between 2019-2020 (using the Convenient Sampling method). This study is a case-control study. Out of 32 patients referred to the vascular surgery department of the hospital, 68.8% were male, and their mean age was 53.41±12.75 years, ranging from 28 to 78 years. Changes in distal arterial hemodynamics of the upper limb before and after clamping in dialysis venoarterial loop versus straight grafts are different in studied patients (P<0.05). The mean hemodynamic changes before and after clamping in loop venoarterial grafts (19.5000) are less than straight grafts. In dialysis patients who do not have any superficial vein suitable for venous, arterial fistula, surgical placement of artificial grafts in the upper limb is appropriate. Based on the results of this study, the loop method seems to have lesser ischemic Complications and can be applied to dialysis patients.

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Introduction

Hemodialysis access has been considered as a support for end-stage renal patients. Approximately 38,000 dialysis patients in Iran and more than 700,000 individuals in the USA and the EU depend on vascular access for hemodialysis treatment (1-3). Although the best way of hemodialysis is through arteriovenous grafts (AVGs), we can't provide this access in many individuals; therefore, we inevitably resort to prostatic arteriovenous grafts to place suitable access for hemodialysis (4-6). One of the relatively common complications of AVGs is arterial steal syndrome, which has occurred in 1.6% to 8% of patients. In some cases, the main treatment for this complication is the closure of AVG. There are two ways of placing AVGs: the straight and loop method. Since proximalization of the arterial anastomosis is one of the treatments for this syndrome, there would be a possibility if we initially provide the arterial anastomosis proximally in the form of a loop, the rate of arterial hemodynamic changes in the distal part of the upper extremity would decrease and therefore steal syndrome would occur less often (7).

The purpose of this study is to determine whether there is a difference in hemodynamic changes in the loop and straight prosthetic AV grafts. Therefore, we measured the hemodynamic changes of the distal part of the upper extremity immediately after providing the AVGs in each method mentioned above and then compared the results. This method is a novel one and hasn't been used in any other studies before.

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Materials and Methods

We studied 32 patients referred to the vascular surgery department of Rasht Razi Hospital between 2019-2020 (using the Convenient Sampling method). This study is a case-control study. Dialysis patients who require prosthetic upper limb grafts as access to dialysis entered the study after obtaining informed consent. All patients had normal Allen tests and palpable radial pulses. Patients were randomly selected by the receptionist of the vascular surgery ward to place an artificial graft in two forms; loop or straight. Surgery was performed on the patients under general anesthesia in the supine position with outstretched upper extremities. First of all, we measured the transverse diameter of the brachial artery and vein in the proximal part of the arm in the loop method and the Transverse diameter of the brachial vein in the proximal part of the arm and brachial artery in the cubital fold in the straight method using Doppler ultrasonography. In the loop method, with a longitudinal incision of the proximal and medial parts of the arm and exploring the brachial artery and appropriate vein, an 8 mm PTFE graft was transversed through a subcutaneous tunnel in the anterior arm in the form of a U shape. The ends of the PTEE graft were anastomosed to the artery and vein end-to-side fashion. In the straight method, first, the appropriate vein in the proximal part of the arm and then the distal part of the brachial artery in the cubital fossa is explored. An 8 mm PTFE graft was transversed through a subcutaneous tunnel in the anterior arm straightly. The ends of the PTEE graft were anastomosed to the artery and vein end-to-side fashion. After establishing blood flow in the graft and sensing the trill, an arterial line in the ipsilateral wrist was prepared. It was assumed that the elimination of AVG shows normal Radial hemodynamics in patients, so we measured distal arterial pressure with a clamp on AVG (Normal situation) and without clamping (post-AVG situation).

Statistical analysis

After collecting the data, all the information was entered into the SPSS software Ver. 22. The results are presented as descriptive statistics in terms of relative frequency. Values were expressed as the mean±standard deviation (continuous variables) or percentages of the group's categorical variables). The normality of quantitative data distribution is performed using the Shapiro-Wilk test. Chi-square or Fisher's exact tests were used to determine the significance of differences. If the variable was normal, we used the independent t-test, and if it was not, the Wilcoxon and Mann-Whitney tests were used. A difference was considered statistically significant if the *P* value was less than 0.05.

Results

Out of 32 patients referred to the vascular surgery department of the hospital, 68.8% were male, and their mean age was 53.41±12.75 years, ranging from 28 to 78 years. (Table 1). In this study, 16 patients underwent surgery for the placement of straight venous dialysis arterial grafts and 16 others for the placement of loop grafts. Arterial hemodynamic changes in the distal of their upper limbs were analyzed (Table 2). 68.8 % of patients who underwent loop or straight surgery were male. Changes in distal arterial hemodynamics of the upper limb in dialysis venoarterial straight grafts are different before and after clamping in studied patients, and according to the comparison of the average in the two groups, these hemodynamic changes are more after clamping than before(P<0.05) (Table 3). Changes in distal arterial hemodynamics of the upper limb in dialysis venoarterial loop grafts are different before and after clamping in studied patients, and according to the comparison of the average in the two groups, these hemodynamic changes are more after clamping than before (P<0.05). Changes in distal arterial hemodynamics of the upper limb before and after clamping in dialysis venoarterial loop versus straight grafts are different in studied patients (P<0.05). The mean hemodynamic changes before and after clamping in loop venoarterial grafts (19.5000) are less than straight grafts (33.5625). The studied patients were followed up for signs of upper extremity ischemia after one month, three months, and six months. Out of 32 patients, 5 patients expired. The follow-up data of the patients after six months were given in Tables (4,5). None of the patients had severe pain during dialysis in the fingers, Persistent pain in the fingers, Wounds on the fingers, and Gangrene fingers.

Table 1. Shows the distribution of risk factors and the underlying diseases in the studied dialysis patients

Risk factor	HTN	Smoking	Asthma	DM	Dyslipidemia	CVA
Percentage	50	9.4	3.1	40.6	6.3	3.1

Table 2. Shows the status of age, venous and arterial diameter, and blood pressure before and after vascular clamping in the two groups of patients who underwent loop and straight placement of arterial grafts

		Straight grafts	Loop grafts
Age	Mean±sd	50.19±14.22	56.63±10.56
	Range	28-74	30-78
Venous diameter	Mean±sd	6.37±1.71	5.72±1.25
	range	4.3-10	4.5±9
Arterial diameter	Mean±sd	5.013±0.81	4.81±1.021
	Range	3.9-6.2	4-8.2
BP before clamp	Mean±sd	70.25±21.098	82.25±25.22
	Range	40-112	40-158
BP after clamp	Mean±sd	102.57±23.78	101.75±24.22
	Range	70-160	52-140

Table 3. The distribution of risk factors and the underlying disease in the studied dialysis patients by type of their grafts

Risk factor	Straight	Loop
HTN	31.3	68.8
Smoking	6.3	12.5
Asthma	0	6.3
DM	50	31.3
Dyslipidemia	12.5	0
CVA	6.3	0

Table 4. Dialysis patients follow up for upper extremity ischemic symptoms and after placement of loop arteriovenous grafts

Dialysis access functioning time	Lack of Radial pulse	Cold fingers	Slight pain during dialysis in the fingers	Severe pain during dialysis in the fingers	Persistent pain in the fingers	Wounds on the fingers	Gangrene fingers
1.5-3 years	28%	50%	14%	0%	0%	0%	0%

Table 5. Dialysis patients follow up for upper extremity ischemic symptoms and signs after placement of straight arteriovenous grafts

Dialysis access functioning time	Lack of Radial pulse	Cold fingers	Slight pain during dialysis in the fingers	Severe pain during dialysis in the fingers	Persistent pain in the fingers	Wounds on the fingers	Gangrene fingers
9months-1.5 years	38%	100%	61%	0%	0%	0%	0%

Discussion

One of the most important complications of vascular access, especially prostatic grafts, is hemodynamic changes in blood flow and ischemia of the hand or steal syndrome. Ischemia is due to Steal syndrome after AV graft causes hand pain and disjunctive and, in server, causes may lead to limb loss. Ischemia due to stealing syndrome, if severe, can cause deformity and loss of limbs. Due to its importance, in this study, the distal arterial hemodynamic changes of the upper extremity in the loop and straight venous dialysis arterial grafts in patients undergoing vascular surgery were compared. One of the treatments of this syndrome is the proximal graft of arterial inflow, so we thought establishing an AV graft in axillary loop design may prevent this compliance by establishing arterial anastomosis in the proximal limb. Hemodynamic changes of the arterial system in the wrist may reflect the import of AV graft in the distal of the limb, and comparing these changes in two techniques (straight and loop form AV) shows the difference between the two techs on distal arterial flow and steal

syndrome. To record these changes after AV, blood pressure was measured once in the clamp graft condition without shunt and once in the open graft position, and the changes were recorded in both cases. Analysis with this method showed that the hemodynamic changes in the loop method are significantly less than the straight one, so it can be predicted that the bleeding syndrome rate is lower in patients with axillary loops. However, the efficiency of the loop method has been confirmed in other studies (1,8). Khoshnevis *et al*., showed that the efficiency and complications of straight grafts and loop grafts were compared in 77 patients. The results did not show a significant difference between the two groups. However, the rate of long-term resilience over the next 2 years was higher in the loop grafts compared to straight grafts (9). In the present study, arterial hemodynamic changes in loop grafts after clamping were less compared to straight grafts. Another study by Elwakeel *et al*., showed that loop axillary-axillary surgery is an acceptable procedure in dialysis patients (10). According to another study by Hunter *et al*., dialysis access surgery with an axillary-axillary loop graft in the upper extremity in a dialysis patient who does not have a suitable vessel to create a venous, arterial fistula may be a good option (8). In the study by Muzaffar *et al*., which was conducted to compare the efficacy and complications of polyurethane and Poly (tetrafluoroethylene) vascular grafts in 60 patients who needed chronic hemodialysis, they divided the patients into two groups of 30. In each group, 15 grafts were directly implanted in the upper limb, and in 15 patients, the graft was implanted in the lower limb in the form of a loop graft. Individuals of these two groups were similar in terms of age, sex, cause of renal failure, and arterial hypertension. The results showed that the rate of vascular complications, including the development of steal syndrome and distal embolism in the upper limb with the lower limb, were not significantly different from each other (11). The findings of the study are consistent with the results of this study. According to these studies, in patients with underlying diseases using the artificial graft, loop grafts can be effective. In the following, some methods are suggested that can be suitable for patients with underlying diseases using loop grafts. In a case-report study, Debing *et al*., by intra-arterial loop angiography, showed that fully operational access and hemodynamic resilience were also appropriate within 8 months of surgery. Axilla-axillary arterial venous fistula has been reported as a suitable method for hemodialysis of diabetic patients with arterial vascular problems (12). In the present study, most patients had no history of an underlying disease.

In dialysis patients who do not have any superficial vein suitable for venous, arterial fistula, surgical placement of artificial grafts in the upper limb is appropriate. Based on the results of this study, the loop method seems to have lesser ischemic complications and can be applied to dialysis patients.

Limitations

These data must be interpreted with caution because the population that was studied was not large enough, and future studies with larger numbers of patients are required to confirm our results.

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