INTERNATIONAL JOURNAL OF MEDICAL ARTS

Volume 5, Issue 5, May 2023

https://ijma.journals.ekb.eg/

Print ISSN: 2636-4174

Online ISSN: 2682-3780

Available online at Journal Website
https://ijma.journals.ekb.eg/
Main Subject [Surgery]

Original Article

Brachial Artery Loop versus Axillary Artery Loop Grafts as Unusual Hemodialysis Angioaccess

Abdelmonem Fareed Abdallah *[1], Mahmoud S. Eldesouky [2], Yahia M. Alkhateep [2]

[1] Department of Vascular Surgery, Faculty of Medicine, Menoufia University, Shebin El-Kom, Menoufia, Egypt
[2] Department of General Surgery, Faculty of Medicine, Menoufia University, Shebin El-Kom, Menoufia, Egypt

Article information

Received: 07-04-2023

Accepted: 31-05-2023

DOI: 10.21608/IJMA.2023.204659.1664.

*Corresponding author

Email: abdelmieniemfareed@yahoo.com

Citation: Abdallah AF, Eldesouky MS, Alkhateep YM. Brachial Artery Loop versus Axillary Artery Loop Grafts as Unusual Hemodialysis Angioaccess. IJMA 2023 May; 5 [5]: 3253-3261. doi: 10.21608/IJMA.2023.204659.1664
.

ABSTRACT

Background: Significant improvements have been made in the quality of care and life expectancy for patients on dialysis over the past decade. Consequently, it is not uncommon to be confronted with patients exhausted by conventional vascular access methods and in need for unusual vascular access to maintain hemodialysis, so arterio-arterial prosthetic loops can offer an alternative option for these patients.

Aim of the work: The purpose of this study is to evaluate and compare two arterio-arterial loop procedures, using the brachial artery in the arm and the axillary artery on the chest wall.

Patients and Methods: This study was conducted as a retrospective non-randomized comparative study between two groups of patients. The first group [group A] included 14 patients subjected to brachial artery loop graft in the arm [BALG], while the second group [group B] included 23 patients subjected to axillary loop graft on the chest wall [AALG].

Results: Statistically significant differences were achieved between the two groups concerning operative time, blood loss, and hospital stay, where the mean operative time was 89.7 ± 5.16 minutes in group A, the mean blood loss was 117.9 ± 31.7 ml, and the mean hospital stay was 3.5 ± 0.71 days; While in group B, Mean operative duration was 122.2 ± 8.45 minutes, mean blood loss was 228.6 ±51.4 ml, and mean hospital stay was 5.29 ± 0.52 days.

Conclusion: The brachial artery loop graft is superior to the axillary artery loop graft and should be a prioritized option when arterial loop access is indicated.

Keywords: Axillary loop graft; Brachial artery loop; Complex hemodialysis access; Vascular access.

INTRODUCTION

The end-stage renal disease [ESRD] patients, demanding hemodialysis, represent a huge burden on health care systems all over the world regarding their increasing numbers and their constant need for good functioning angio-acesses [1]. In fact, more than 25% of all ESRD patients administered to hospitals are requiring either establishing or getting aftercare for vascular hemodialysis access [2].

Unfortunately, the vascular accesses have certain endurance, and there is a limit to the number of fistulas the upper limb can bear; while the survival rate of ESRD patients is continuing to rise [3]. Synthetic grafts are considered the alternative option for those patients with no more suitable veins for fistula formation, although their durability is less than that of a naturally occurring arteriovenous fistula [4].

Many authors have proposed the use of an arterial conduit as an alternative entry for hemodialysis; Brittinger *et al.* used subcutaneous fixation of the superficial femoral artery to make it possible to puncture the artery. Additionally, Butt and Kountz reported seven patients who underwent arterial femoropopliteal grafting with vascular access from a cow carotid artery all had positive outcomes [5]. Axillary-axillary inter-arterial chest loop conduit was introduced by **Bünger *et al.*** 2005 in 20 patients, with exhausted native fistulas, and also showed good results [6]. We also found that an arterio-arterial loop transplant involving the first segment of the axillary artery is an acceptable alternative to direct vascular access [7].

In this work, we conducted a retrospective comparative study between the brachial and the axillary arteries arterio-arterial loops in the arm and the chest wall respectively as alternative lifelines for hemodialysis.

PATIENTS AND METHODS

Between June 2013 and January 2021, Patients on hemodialysis for chronic kidney disease who met our institution's inclusion requirements were included in this comparative retrospective analysis. Also, hemodialysis patients subjected to arterio-arterial interposition prosthetic loop graft procedures were included. Study patients were categorized into two groups of patients; the first group [group A] included 14 patients subjected to brachial artery loop graft in the arm [BALG], while the second group [group B] included 23 patients subjected to axillary artery loop graft on the chest wall [AALG]. This study was approved by the Committee of Ethics and human research of our institution [Menoufia University Hospitals]. A signed informed consent of the procedure was achieved in all patients. Our study followed the Helsinki Declaration principles. The arterio-arterial prosthetic grafts in this study were indicated in the following: 1] Patients with stenosis or occlusion of all six veins or five veins in younger patients with a favorable prognosis, including the subclavian, internal jugular, and femoral veins. 2] Patients with critical peripheral ischemia due to stealing syndrome after all their native arteriovenous access sites were exhausted. 3] Patients couldn't tolerate an additional cardiac load produced by the arteriovenous graft high flow due to their cardiac insufficiency status.

Data collection

Arterial evaluation data, including pulse assessment, blood pressure [BP] measurement, and duplex ultrasound scanning and mapping were all a part of the pre-intervention assessment.

Surgical procedure

Clinical examination and imaging findings informed the decision regarding the access location. All axillary artery loop graft [AALG] operations were carried out under general anesthesia [GA]. When necessary, the surgical staff opted to use either general anesthesia [GA] or local anesthetic [LA] to correct a hematoma or occlusion. With anesthesia induction, two grams of an antibiotic of the third-generation cephalosporins were injected. An infraclavicular incision was done and the axillary artery was identified following, the dissection of the fibers of the pectoralis major muscle, and transection of the pectoralis minor muscle just below the coracoid process. Following axillary artery division, a subcutaneously tunneled loop was configured on the chest wall, and an expanded polytetrafluoroethylene [ePTFE] graft was interposed [figure 1].

During surgery, the surgeon determined the appropriate amount of the PTFE graft by measuring the patient's axillary artery diameter. The extremities of the prosthesis were anastomosed to the beginning of the axillary artery using a 6/0 polypropylene suture [figure 2]. The graft length ranged from 30 to 40 centimeters after implantation. A drain was left in the infraclavicular wound, as considered appropriate by the operating surgeon.

Under regional or local anesthesia, a 6- to 8-centimeter-long skin incision was made on the medial aspect of the middle third of the arm, directly throughout the brachial artery. Next, the brachial artery was identified, dissected, and isolated from the adjacent veins and nerves, most notably the median nerve [figure 3]. With the help of three tiny counter incisions, a 6-mm expanded polytetrafluoroethylene [ePTFE] graft was tunneled subcutaneously in a loop over the anteromedial aspect of the limb. An end-to-end anastomosis was created between the prosthetic and the Brachial artery using a 6/0 polypropylene suture [figure 4].

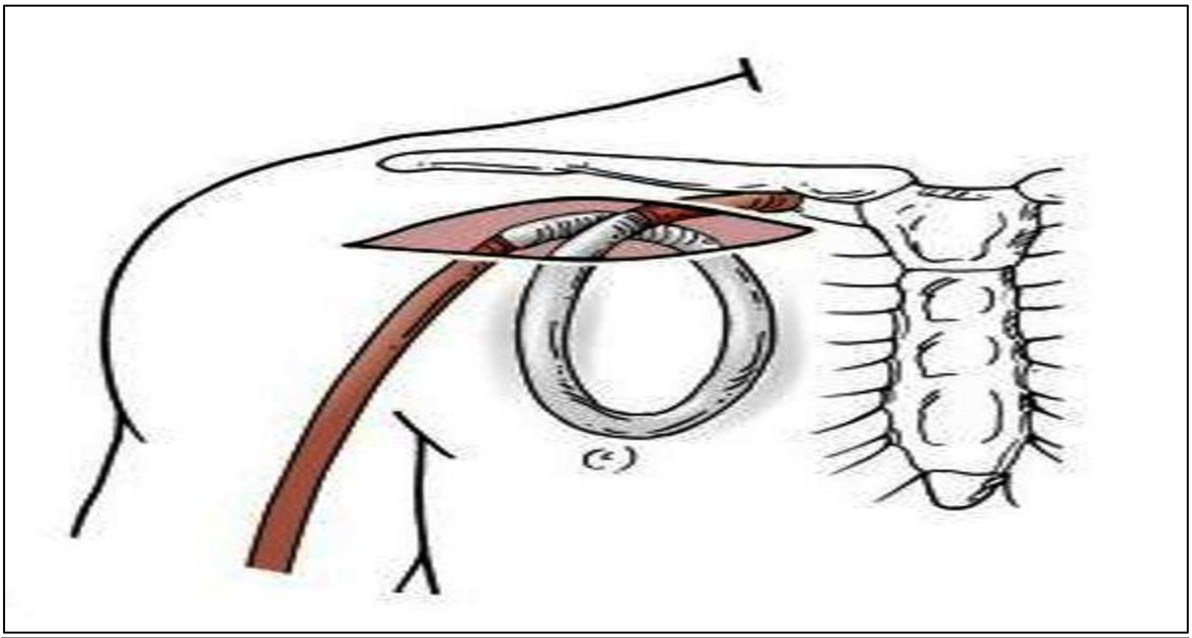

Figure [1]: illustration for axillary loop interposition graft

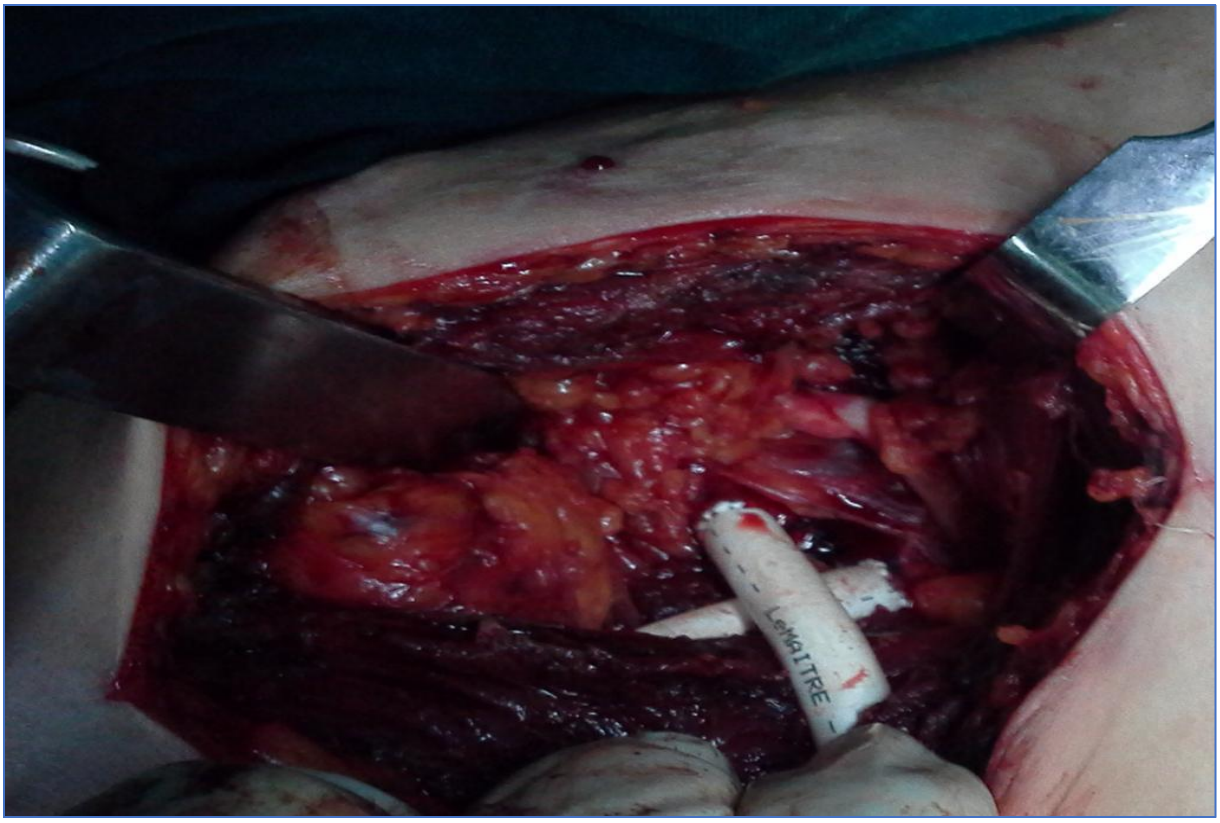

Figure [2]: Anastomosis of loop ends to axillary artery

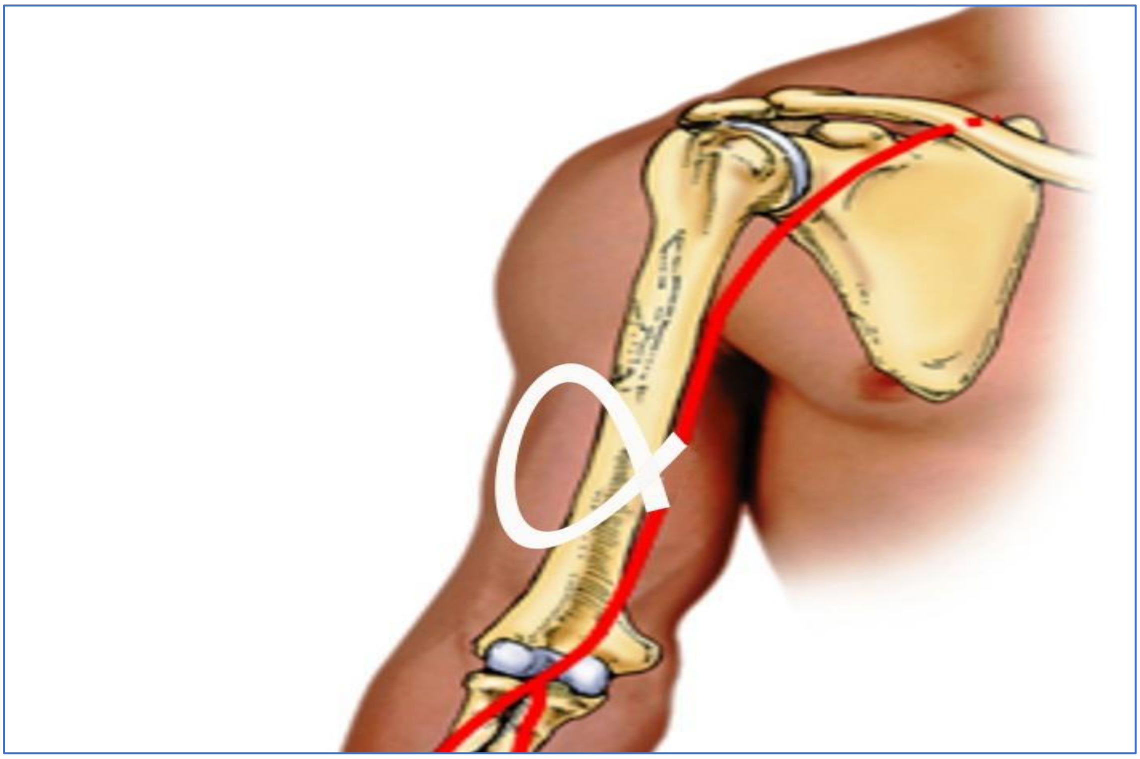

Figure [3]: illustration for brachial artery loop interposition graft

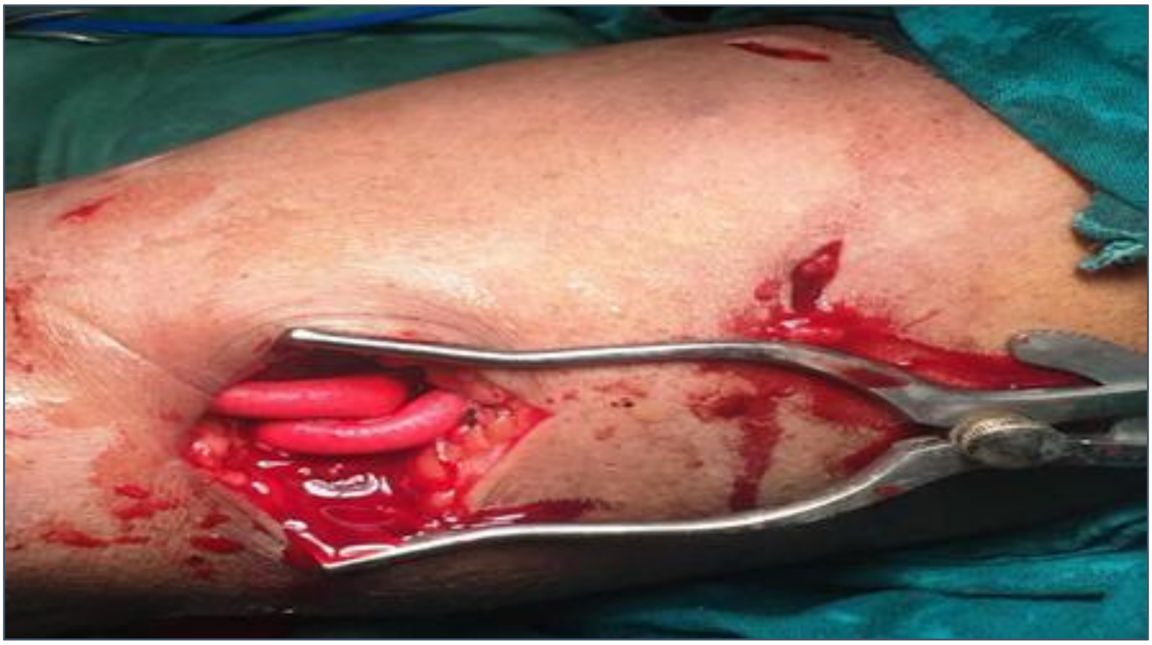

Figure [4]: Anastomosis of loop ends to brachial artery

The therapeutic dosage of low molecular weight heparin was given to all patients for five days, and then warfarin was given orally as a permanent anticoagulant. Two weeks after the operation, the graft was first pierced with a syringe. Before and after access was inserted, blood flow was monitored with a 12-MHz scanning probe in the axillary and brachial arteries. Additionally, the flow rate was determined by taking readings at three distinct locations along the loop's pipe. Chart reviews were conducted to prepare the data for statistical analysis, including patient demographics, preoperative diagnostic workups, treatments, outcomes, and follow-up visits.

Statistical analysis

Statistical analysis was performed using SPSS version 24.0. [IBM Corp., Armonk, New York, USA]. Qualitative data were described using numbers and percentages. Shapiro-Wilk test was used to verify the normality of distribution Quantitative data were described using range [minimum and maximum], mean, standard deviation, and median. Comparisons between groups for categorical variables were assessed using the Chi-square test [Fisher or Monte Carlo]. Student t-test was used to compare two groups for normally distributed quantitative variables. Mann-Whitney test was used to compare two groups for not normally distributed quantitative variables. The significance of the obtained results was judged at the 5% level.

RESULTS

Between June 2013 and January 2021, out of 3877 hemodialysis accesses procedures performed in our institution, 37 patients fulfilled the inclusion criteria of this study. Patients were categorized into two groups, group A, which included 14 patients who were subjected to brachial artery loop graft, and group B, which included 21 patients who were subjected to axillary artery loop graft. Preoperative patient demographic and access characteristics are described in [table 1].

As regards the dialysis period, it was 6.5 ± 4.1 years in group A, and 6.1 ± 3.6 years in group B, with no significant difference between the 2 groups [P value = 0.1]. At the time of intervention, patients were dialyzed through a temporary CVC placed in the jugular vein in 28.6% and 30.4% of the patients, in the femoral vein in 64.3% and 56.5% of the patient, and through insufficient AV graft in 7.1% and 13% of the patients in group A and group B respectively. Arterial loop graft was indicated in the two groups because of exhausted access options in 23 patients [62.1%], heart failure in 13 patients [35.1%], and steal syndrome in 1 patient [2.7%]. In five patients [35.7%] of group A, the construction of the brachial loop graft was performed under local anesthesia, while in the other 9 patients [64.3%] it was carried out under regional anesthesia. All the patients in group B were operated on under general anesthesia.

Two patients in group A developed an early postoperative complication, one developed early thrombosis on the first postoperative day and was successfully treated with surgical thrombectomy using Fogarty's catheters [Lemaitre vascular], and the other developed a superficial wound infection that was treated with antibiotic therapy based on the culture and sensitivity results. Five patients in group B experienced early postoperative bleeding, with three requiring wound exploration and hemostasis and the other two responding well to cautious treatment with fresh frozen plasma and urgent dialysis. In addition, two patients developed early thrombosis and were effectively treated with surgical thrombectomy, and two patients developed a mild wound infection and were treated with antibiotic therapy under the culture and sensitivity finding.

During the time of observation, one patient in Group A and two patients in Group B passed away. The loss of dialysis access or complications from the procedure were not factors in any of the fatalities in either group. Four patients [28.5% of the total] experienced late postoperative graft thrombosis of the brachial artery; these grafts were treated with surgical thrombectomy and completion angiography of the entire access circuit to identify any residual thrombus load and possible underlying cause of graft thrombosis.

Two transplants were found to have anastomotic stenosis, and these were treated with balloon angioplasty utilizing high-pressure balloons. [Boston Scientific Marlborough Mass]. Three out of seven instances of late axillary loop graft thrombosis were successfully treated with re-interventions, restoring graft patency. Patients with failed thrombectomies in the two groups suffered mild ischemic symptoms and were managed conservatively.

Late graft infection took place in one case in group A and four cases in group B. The five patients in the two groups were not responding to conservative treatment and thus were managed in group A by ligation of the brachial artery, and the graft loop was removed under local anesthesia [there was no need for distal revascularization as ligation was below the level of profunda brachial artery]. In group B the graft was removed and the axillary artery was reconstructed by an autogenous greater saphenous vein under general anesthesia [table 2].

One patient in group A and seven patients in group B developed graft pseudoaneurysms as a result of repeated puncturing at the same site. In all instances, interposition-expanded polytetra-fluoroethylene grafts were used to reconstruct the damaged graft [figures 5 and 6].

The primary patency and secondary patency were 64.3% and 85.7% in group A compared to 65.2% and 73.9% in group B [figure 7].

Table [1]: Demographic and access characteristics in the two studied groups

		BALG Group A [n=14]	AALG Group B [n=23]	Test of sig.	P value
Sex	Male Female	6 [42.9%] 8 [57.1%]	10 [43.4%] 13 [57.6%]	χ^2= 0.077	0.782
Age [years]	Mean ± SD	54.9 ± 12.8	50.5 ± 11.1	t= 0.765	0.234
Co-morbidity	Diabetes	8 [57.1%]	14 (60.8%)	χ2=0.739	0.390
	Hyperlipidemia	6 [42.9%]	9 (39.1%)	χ2=0.333	0.564
	Cardiac	4 [28.6%]	10 (43.4%)	χ2=1.389	0.239
Period of hemodialysis	Mean ± SD	4.5 ± 1.37	3.9 ± 1.12	t= 0.404	0.15
Vascular access	CVC Femoral catheter Av shmt [B]	4 [28.6%] 9 [64.3%] 1 [7.1%]	7 [30.4%] 13 [56.6%] 3 [13%]	χ^2= 0.509	^{MC}p= 1.000
Indicational AALG access					
Exhamsled access options		9 [64.3%]	14 [60.8%]	χ^2=0.020	0.886
Heart failure [CA]		4 [28.6%]	9 [39.2%]	χ^2=0.047	^{FE}p=0.72
Steal		1 [7.1%]	0 [0 %]	χ^2=0.061	^{FE}p=1.000

SD: Standard deviation; χ^2: Chi square test; t: Student t-test; MC: Monte Carlo; FE: Fisher Exact;
*: Statistically significant at $p \leq 0.05$

Table [2]: Comparison between the two studied groups according to operative data and complications

	BALG Group A [n=14]	AALG Group B [n=23]	Test of significance	p
Operative time [min.], Mean ± SD	89.7 ± 5.16	122.2 ± 8.45	t=12.404*	<0.001*
Blood loss [ml], Mean ± SD	117.9 ± 31.7	228.6 ± 51.4	t=7.24*	<0.001*
Hospital stay [days], Mean ± SD.	3.50 ± 0.71	5.29 ± 0.52	t= 8.21*	<0.001*
Complication				
Thrombosis	5 [35.7%]	8 [34.8%]	χ^2 = 0.020	0.886
Infection	2 [14.2%]	6 [26%]	χ^2 =0.088	^{FE}p=0.68
Bleeding	0 [0.0%]	5 [21.7%]	χ^2 =3.889	^{FE}p=0.069
Psendoaneurysm	1 [7.1%]	7 [30.3%]	χ^2 =3.268	^{FE}p=0.108
Mortality	1 [7.1%]	2 [8.6%]	χ^2 =0.061	^{FE}p=1.000
1^{ry} patency at 1 year	9 [64.3%]	15 [65.2%]	χ^2 =0.020	0.886
2^{nd} patency	12 [85.7%]	17 [73.9%]	χ^2 =0.134	^{FE}p=1.000

SD: Standard deviation; t: Student t-test; U: Mann Whitney test; χ^2: Chi square test; FE: Fisher Exact; *: Statistically significant at $p \leq 0.05$

Figure [5]: Excised graft pseudo aneurysm

Figure [6]: Reconstruction after replacement of the destroyed graft segment

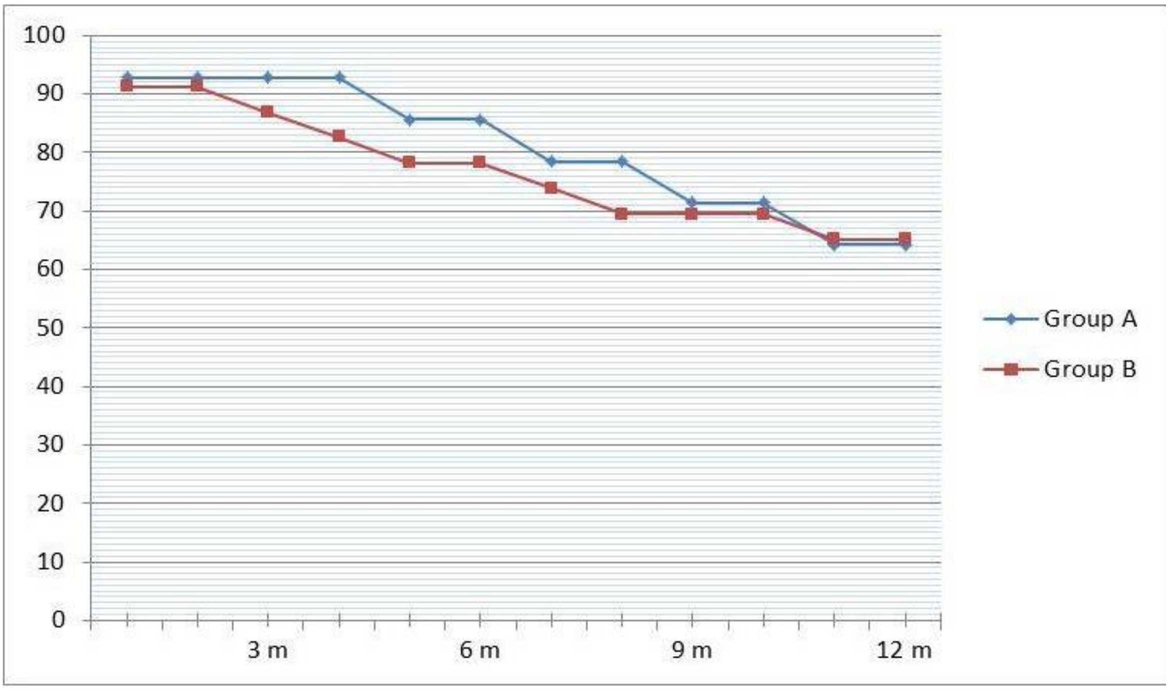

Figure [7]: Percentage of survival with patency in both groups at the follow up periods

DISCUSSION

National Kidney Foundation Dialysis Outcomes Quality Initiative [NKF-DOQI] guidelines recommended using native arteriovenous fistulas as the most preferred method for obtaining arterial access before implantation of the arteriovenous [AV] grafts, it is not unusual, however, to encounter patients whose choices for non-invasive vascular access have been exhausted., and these patients represent a great challenge to vascular surgeon due to their need for complex hemodialysis accesses [9].

Cuffed tunneled central venous catheters are considered alternative dialysis access pathways for patients with exhausted vein options, however, the difficulties already experienced by patients with central venous occlusions are exacerbated by the use of central venous devices for either temporary or permanent access especially, the permanent vascular accesses which cause thrombosis, infections, and displacements, increasing morbidity, the mortality, hence, the use of those central venous vascular accesses should be discouraged [10].

Arterial prosthetic loop grafts represent one of the complex accesses that could be offered for patients with exhausted conventional options. The utilization of an artery is not considered a new alternative concept for making permanent vascular access, since numerous researchers first reported on it, beginning with Brittinger *et al.* in 1969 [7].

There is no consensus about the ideal site for arterio-arterial loops, studies on axillary, femoral, and brachial arteries were performed, with no head-to-head comparative study to evaluate the superiority of one site to other sites for arterial loop creation. In this study, we performed a head-to-head comparative study between axillary and brachial prosthetic loop grafts, the baseline characteristics were comparable in the two groups.

The graft thrombosis rate was comparable with no statistical differences between the two groups, there was no manifestation of distal limb ischemia with graft thrombosis and was discovered only during a dialysis session. There is a controversy between studies about the incidence rate of distal ischemia, **Khafagy *et al.*** [11] reported that about 35% of graft thrombosis presented with mild to moderate distal ischemia which represents a high percentage and cannot be explained as in the same study all cases of graft infection and removal with ligation of brachial artery did not show any distal ischemia. Although **Lei *et al.*** [12] emphasized the need for prompt thrombectomy to prevent ischemia, however, in their patients with graft thrombosis no distal ischemia was noted. Similar to **Lei *et al.*** [12], **Bünger *et al.*** [6] found that distal ischemia happened during early thrombosis but not late thrombosis.

Good collaterals represent the protective barrier against distal ischemia and we think dissection with preservation of all collaterals should be mandatory in all cases. Patients who developed distal ischemia may be explained by thrombus propagation with occlusion of collateral or by the presence of iatrogenic intimal injury or technical error, especially in cases of early graft thrombosis and distal ischemia. There was no significant statistical difference in primary and secondary patency rates between the two groups of our study and both the findings of **Khafagy *et al.*** [11] and **Lei *et al.*** [12] were comparable in terms of primary and secondary patency rates. On the other hand, **Zanow *et al.*** [3] reported lower primary and secondary patency results. These lower patency rates may be explained by technical issues as they had reported that 50% of thrombosed grafts needed repair of anastomotic stenosis.

Brachial artery loops procedures showed, statistically significant, shorter procedure time and lower blood loss when compared to the axillary loop group; shorter hospital stays also was detected in brachial artery loop patients. Graft infection and removal were comparable in the two groups, brachial artery ligation after graft excision did not result in distal ischemia with no need for reconstruction; in the axillary artery loop group arterial reconstruction was performed in all cases after graft excision.

Other studies by **Rahim *et al.*** [13] and **Khafagy *et al.*** [11] reported similar results of no distal ischemia after graft excision and artery ligation.

By comparing the two interventions, brachial artery loops have superiority over the axillary artery loops as brachial artery procedures were performed under local or regional anesthesia, while axillary artery procedures needed general anesthesia. Moreover, in contrast to axillary access, which was more crucial in female patients, brachial access was more convenience for both the patients and the medical staff.

The main drawback that was faced while making the brachial loop, is the presence of an ugly scar at the operation site on both arms or previous ligation of the brachial artery as a result of previous AV fistula rupture, which in both cases hindered the creation of the loop.

In our study, the incidence of pseudo-aneurysm was detected at multiple puncture sites and also as a result of the graft's high arterial pressure. The avoidance of this complication was resolved by rotating the site of the needle puncture and by the use of thick wall grafts when available. Instructions to renal unit staff were performed about proper compression after needle removal and avoiding administration of drugs through the arterio-arterial loop graft. In our patients, the median access flow rate was adjusted to 150 to 160 mL/min at rest, and the blood withdrawal to 200 to 250 mL/min.

Conclusion: When complex hemodialysis access is indicated both Brachial and axillary artery loop graft offers comparable results regarding patency rate. Brachial artery loop graft may be preferred because of the shorter procedure time, which can be performed under local anesthesia, and a simpler procedure, brachial artery ligation, can be performed in case of graft infection and removal with no need for arterial reconstruction. We recommend future multicenter randomized control studies be initiated to include a larger number of cases to avoid the limitation of the rarity of cases.

Conflict of Interest and Financial Disclosure: None.

REFERENCES

1. Afsar B, Elsurer R, Covic A, Kanbay M. Vascular access type, health-related quality of life, and depression in hemodialysis patients: a preliminary report. J Vasc Access. 2012 Apr-Jun;13[2]:215-20. doi: 10.5301/jva.5000032.
2. Kaneda H, Kaneda F, Shimoyamada K, Sakai S, Takahashi M. Repeated femoral vein puncturing for maintenance haemodialysis vascular access. Nephrol Dial Transplant. 2003 Aug;18[8]:1631-8. doi: 10.1093/ndt/gfg205.
3. Zanow J, Kruger U, Petzold M, Petzold K, Miller H, Scholz H. Arterioarterial prosthetic loop: a new approach for hemodialysis access. J Vasc Surg. 2005 Jun;41[6]:1007-12. doi: 10.1016/j.jvs.2005.02.043.
4. Lok CE, Foley R. Vascular access morbidity and mortality: trends of the last decade. Clin J Am Soc Nephrol. 2013 Jul;8[7]:1213-9. doi: 10.2215/CJN.01690213.
5. Scholz Hans. Arterioarterial Grafts: Ch. 5. In Arteriovenous Access Surgery Ensuring Adequate Vascular Access for Hemodialysis. Berlin: Springer Berlin, 2016, 107–110.
6. Bünger CM, Kröger J, Kock L, Henning A, Klar E, Schareck W. Axillary-axillary interarterial chest loop conduit as an alternative for chronic hemodialysis access. J Vasc Surg. 2005 Aug;42[2]:290-5. doi: 10.1016/j.jvs. 2005.04.022.
7. Fareed A, Zaid N, Alkhateep YM. Axillary artery loop interposition graft [AALG] as unusual access for hemodialysis. Int Surg J. 2017 Nov 25;4[12]:3853-7.. doi: 10.18203/ 2349-2902.isj20175154.
8. Quinn BM, Cull DL. Complex Hemodialysis Access. ch 73, in Rutherford's Vascular Surgery, 7th ed. 2010. Elsevier SP - 1115-1126.
9. Ali H, Elbadawy A, Saleh M. Midterm outcomes of brachial arterio-arterial prosthetic loop as permanent hemodialysis access. J Vasc Surg. 2020 Jul;72[1]:181-187. doi: 10.1016/ j.jvs.2019.10.081.
10. Dammers R, de Haan MW, Planken NR, van der Sande FM, Tordoir JH. Central vein obstruction in hemodialysis patients: results of radiological and surgical intervention. Eur J Vasc Endovasc Surg. 2003 Sep;26[3]:317-21. doi: 10.1053/ejvs.2002.1943.
11. Khafagy T, Regal S, ElKassaby M, Saad E. Early Results of Brachial Arterio-Arterial Prosthetic Loop [AAPL] for Hemodialysis. Eur J Vasc Endovasc Surg. 2016 Jun;51[6]: 867-71. doi: 10.1016/j.ejvs.2016.02.010.
12. Lei W, Ji J, Wang J, Jin L, Zou H. Arterioarterial Prosthetic Loop as an Alternative Approach for Hemodialysis Access. Medicine [Baltimore]. 2015 Oct;94[41]:e1645. doi: 10.1097/MD.0000000-000001645.
13. Rahim AMAA, Bush A, Ahmed AAS, Soliman AM, Ismail MAM. Infraclavicular arterio-arterial prosthetic loop is a safe and effective vascular access technique for haemodialysis in frail patients: a prospective observational study. Pan Afr Med J. 2021 Dec 21;40:245. doi: 10.11604/pamj.2021.40.245. 29390.

International Journal of Medical Arts

https://ijma.journals.ekb.eg/
Print ISSN: 2636-4174
Online ISSN: 2682-3780