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RESEARCH ARTICLE

APPLICATION OF M SHAPE ARTERIO-VENOUS ACCESS GRAFT FOR HEMODIALYSIS IN VERY OBESE PATIENTS WITH NATIVE SHORT LENGTH ARM

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ABSTRACT

Introduction: Since a decade ago, M shape hem dialysis access had been created in our department for patients with native short length arms. Short arm obese and very obese patients also are the rare main targets for its application.
Method: This is a case control series study of9obese patients, 2 males and 7 females (BMI≥40, mean=44.80) (6 cases obese class III, 3 cases class II, mean weight=105.55 Kg)who were referred for hem dialysis access. They had short length arm and were selected during 32months. Expanded polytetrafluoroethylen was used for M shape Brachial-Axillary access under regionalor local anesthesia. Primary and secondary patency (3,6, 12 months) was followed and patients were compared to the other non-obese control group for patency, effective length and graft outgoing flow. One-year follow up has been considered.
Results: Of nine patients, 6female patients were diabetics. Mean effective length of arms was 16.21Cm, (P=0.001). Patients have effective hem dialysis during primary and secondary follow up. In comparison with straight grafts, color Doppler was shown no considerable velocity difference due to the spiral status (P= 0.877 arterial outflow, P=0.625 venous outflow). Primary patency was 100%, secondary patency in 3, 6, 12 months were 88%, 55.56% and 44% respectively.
Conclusion: M shape arterio-venous graft access was shown efficient for obese and very obese withnative bi-articularshort length arms with or without diabetes that conventional access techniques are not feasible. Dialysis ought to perform by educated familiarized staff.

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INTRODUCTION

Prosthetic arterio-venous grafts are shown to be the second accepted alternative technique after autogenous arterio-venous fistulas (AVF).Populations who require hem dialysis are rapidly increasing and have become more complex with common co-morbid conditions (Donovan, 2005). Many reasons such as spreading End Stage Renal Disease (ESRD), decreasing efficiency of AVF with obesity, and increasing incidence of diabetes nephropathy that inevitably requirehemodialysis (Resic, 2005), advocate special consideration that mainly necessitate current improving of conventional access techniques and procedure individualization. Basically, access quality and efficiency are the two mandatory characteristics, imperative for effective and convenient hem dialysis performance and also accepting the reliability of techniques used by expert surgeons with the existence of suitable vascular beds. Many interfering factors such as age, diabetes and obesity have reported intensively as predictive factors regarding the non-functional accesses (Resic, 2005 and Naffouje, 2016), that strongly affect promoting access patency alongside its acceptable survival expectation. Superimposing complication of long lasting catheters, venous hypertension with edema, post stricture obstructions and infections are also implicated because incorrect patient's management in which are surgeon related judgment for treatment decisions and account for second step of failures. Accordingly, application of compositeself-sealing grafts or polyurethane conduits, which possess the property of early needle insertion for excluding catheters (Jefic, 2005), HeRO grafts for distal venous problems (Katzman, 2009) and Chlorhexidine with Silver-sulfadiazine impregnated catheters have been fixed and popular as their prototype solutions. Nevertheless, whatever is mainly required is concentration on anatomic features of the patients as accessible healthy deep

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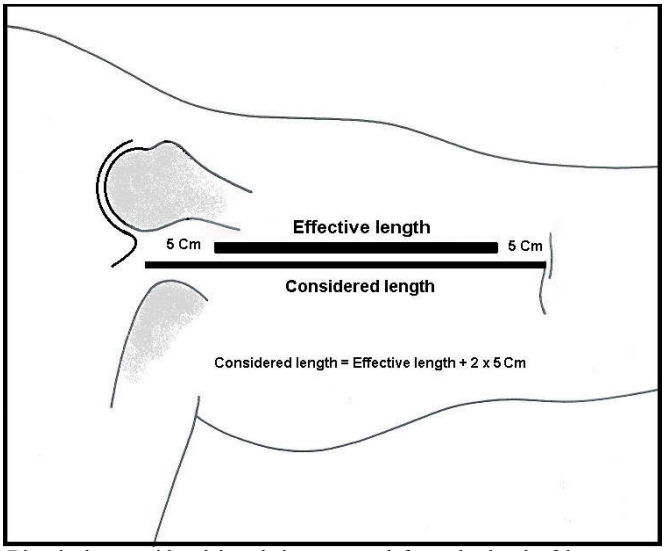
veins and suitable arterial diameter with good run off accompanied by effective graft length so enough that to construct an advantageous and efficient arm graft access; the situation that may not always provided in complex severe obese who has natively short length arms, especially diabetics. In order to provide certain conditions in such a rare population who their arms do not give proper required available length for accessible graft in dialysis for needle insertions (at least 15 cm), a proper adjusted alternative technique presumed necessary. Hence, as we had already got the experience of successful, longtime patent, sporadic Spiral M shape graft construction in selected ESRD patients who had no chance of AVF and simultaneously other acceptable graft insertion techniques; complaining of dialysis stuff for lack of certain distances for needle injections and finally in-effective hem dialysis results of patient's laboratory and clinical conditions that characteristically involve them, we have decided to arrange the application of spiral technique for their new selected cases. Thus, the aim of the present study was programmed to focused on investigating the effectiveness of the procedure for hem dialysis obese and very obese candidates possess native short length arms and comparing them with other conventional straight arm grafts for quality of the flow, patency and effective length.

MATERIALS AND METHODS

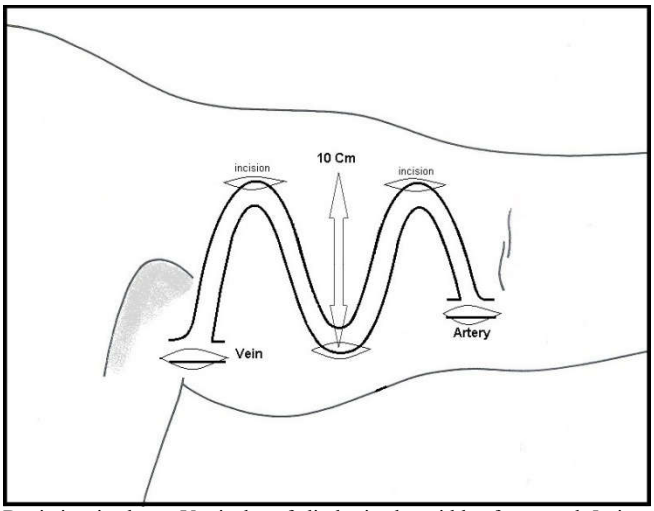
This wasa case control series trial in 9 obese patients with ESRD who were required access for hem dialysis. Of referred ESRD cases to our vascular clinic affiliated to Ahwaz Jundishapour University of Medical Science, Ahwaz-Iran, obese patients with or without diabetes with short length arm whoin them AVF and other standard techniques were not feasible, were recruited. Since we have already used the technique in our department for selected patients to create a hem dialysis access, the study was designed to introduce its usefulness for very obese candidates as explained. All patients gave their written informed consents prior to commencement of the study according to ethical approval conform to the guidelines of 1975 declaration of Helsinki and approved research projects of university institution and faculty research registration No: D/385. Totally, nine patients, 7 female and 2 males from 28 to 57 years old (mean = 43.55) have been operated forM shape accesses during32 months. The flow velocity of constructed functional access, bi-articular distance of arms and effective length of grafts were compared to non-obese straight Brachial-Axillary accesses as control group. BMI and demographic features and diabetes involvement has been considered but were not compared in two groups. Routinely, in our Department, we consider an "effective length" of arm for efficiency of all types of straight or loop grafts after access preparation defined for insertion of hem dialysis needles by its staff. The length for graft implantation differs and defined as "considered length" that is two inches below from the head of humorous bone (Delto-Pectoral groove) and two inches above the crease of ante-cubital fossa in all patients (Figure, 1). This effective length is presumed the least necessary and routine accessible graft distance for every two safe andalso successive injections for hemodialysis and maintaining conduit long patency in our experience and is variable about 15-20 cm. We have selected the obese patients who their arms have not given this effective length. In suggested technique, we only used 6 mm standard wall, commercial flexible kind of expandedpolytetrafluroethylen grafts with 40 cm length. Donor artery wasbrachial artery inmedial arm supra cubital region and recipient vein was axillary vein just in the proximal of axillary fossa.



Bi-articular considered length is accounted from the head of humorous bone in Delto-Pectoral grooveto theante-cubital crease of elbow = Effective length plus 2 × 5Cm. Considered length is used to implant a straight curved bridged access. Effective length express as the least necessary distance that the graft has to be available for dialysis and multiple successive injections during graft patency.

Figure 1. Theeffective bi-articular length and considered length for graft implantation

For implantation, two2-3cm incisions is necessary for arterial and venous side exposure and three 1.5-2cm incision for every pocket formation to curve the graft for M shape or spiral feature (Figure 2).

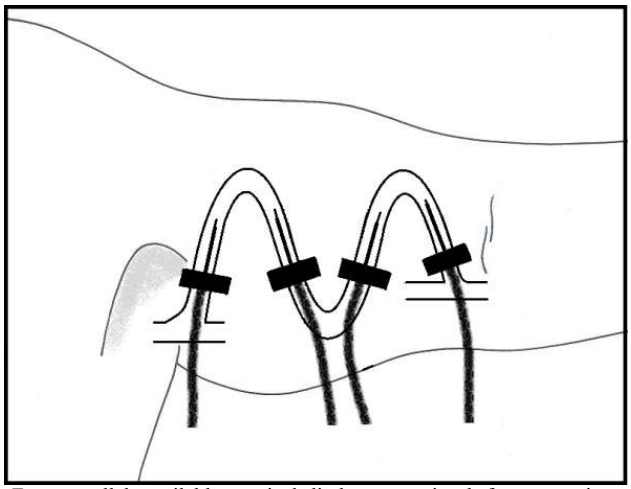


Depiction is shown:Vertical graft limbs in the width of arm and 5 sites ofincisions for turning and inserting the graft. Extensionfor least suitable10 Cmvertical graft limbs is usually attainable. Providing5-7 Cm vertical length, fouraccessiblegraft limbs for multiple injections for hemodialysis.

Figure 2. Access graft construction inthe form of spiral M shape

The curve of the graft in eachturning sitewas contained two-tip fingers internal bed (about 2.5 cmcircle radius) in order to prevent kinking. Confirmation of "primary graft patency" was checked in the third and then seventh days and two weeks post operative. All intervening patients and control group were studied and recorded by Doppler sonogram for "Arterial side" velocity (proximal of graft) and "venous side" outflow (distal of graft) prior to being referredfor hemodialysis in the time of controlling primary patency. After two post-operative weeks functional grafts were referred for hemodialysis on a depicted

access mapping as a guide for dialysis staff. Patients were also followed up41 0144778865at 3,6 months and first year post dialysis periods respectively. Dialysis staffs were surveyed on the applied technique during dialysis and the convenience of needle insertions based on hem dialysis apparatus by filing a questioner during the study. Data analyzed using Chi-square and paired T Tests with ANOVA confirmation through SPSS.17 software.



Four parallel available vertical limbs are existed for convenient insertion of needles by dialysis staff in the abduction position of arm.

Figure 3. Demonstration of needle insertions

RESULTS

6 of 9 patients were involved by Diabetes who were all female and had history of more than 10 years (12 – 27 years) involvement.

Average BMI was 44.80 Kg/m^2. All nine patients also had history of blood hypertension in the range of 145-220 mmHg that in two of them it was fixed above 200 mmHg. Their arm "considered length" as depicted in figure 1, were from 18.5 to 24 cm (mean = 21.16 cm) and consequently the "effective length" were 8.5 to 14 (mean = 11.16) cm compared to mean considered arm length of straight control group, 26.33 cm (P = 0.001). Mean mid-arm patients circumference were 43 cm and intra operative width for a 10 cm vertical limb in all were obtained. Total grafts were functional with good bruit and thrill in their proximal limb of the access and also as primary patency in the first three weeks of post construction. Outflow velocity in arterial and venous sides in Doppler recording were obtained as mean patients' arterial outflow = 1181.66 cm/s, mean patients' venous outflow =1078.33 cm/s for M shape grafts which were compared to straight control group as mean arterial outflow = 1148.88 cm/s, mean venous outflow = 1136.66 cm/s (P = 0.877 for arterial flow, P = 0.625 for venous outflow (95% confidence interval) comparing between M graft group and control group. P value for comparing between the two sides of arterial outflow and venous outflow in M shape grafts was 0.497 (Table 2). During control for secondary patency one case was thrombosed after dropping the blood pressure due to septicemia and the patient was under attack dose of vancomycin treatment and was followed by dual catheter. Two cases were made hematoma in the sites of needle insertions but the grafts were functional. Other patient accesses in spite of many admissions for nephrology follow up and fluctuated blood pressures were functional under hemodialysis. One diabetic patient died at 6 months post operation due to heart failure and two grafts were blocked due to false aneurysms. 3 cases were referred by dialysis staff because of progressive and relative mild to severe edema of extremities.

Table 1. Results of Mshape graft control, up to one year

Follow up	Graft function	Complications	Dialysis status
Primary patency, (3 weeks)	100% n = 9	---	9, accepted - good
Secondary patency, (3 months)	88.89% n = 8	One graft thrombosis, Two needle site hematomas	6, accepted - good 2, accepted - fare
Six months	55.56% n = 5	Two false aneurysms, Three extremity edema	2, accepted - good 3, accepted- feasible
One year	44.44% n = 4	One persistent edema,	4, accepted - good

Graft patency and function based on resulted data for one year, consideringdependent complications, dialysis status according to stuff questionnaires. Good: convenience of patient and staff. Fare: convenient dialysis, patient discomfort. Feasible: discomfort of patient and staff.

Table 2. Scales of flow rates and arm length in case series

Outflow rate				Bi-articular Arm distance			
M shape group		Control group		M shape group		Control group	
Arterial	Venous	Arterial	Venous	Considered L.	Effective L.	Considered L.	Effective L.
1181.66	1078.33	1148.88	1136.66	18.5-24 Cm	8.5-14 Cm	22.5- 32 Cm	12.5- 22 Cm
Arterial Mean comparison, P= 0.877 Venous Mean comparison, P= 0.625 M grafts Arterial to Venousoutflow, P=0.497				Mean= 21.16	Mean 11.16	Mean = 26.33	Mean= 16.33
				Mean effective length comparison,P ≤ 0.001			

L, length.

Table 3. Overall advantages and difficulties of M shape spiral graft implantation

Advantages	Difficulties
1-Accessible placement of efficient limbs 2- Producing at least fourverticalaccessible lengths of 5-7 Cm. 3- Possibility of vertical and parallelinsertion of needles (figure 3). 4- Producing certain suitable distance for injection for prevention of flow interference 5- Providing possibility of graft implantation under local-regional block anesthesia with mild sedation	1- Multiple incisions 2- multiple injections for local anesthesia. 3- Multiple tunneling(increasing hematoma formation with anti coagulants). 4- More possibility of velocity gradient between donor artery and recipient vein during hypotension (less than 100 mmHg). 5-Early thrombosis with blood pressure fluctuations. 6- difficult thrombectomy; though is feasible.

They had given the history of inserted more than two bilateral long duration (>3 weeks) central dual catheter in their region. Both of the M shape grafts were functional and edema was supported by conservative treatments. One-year follow up resulted in 4 functional grafts without any complication (Table 1). One case was referred back after one year that inevitably required a new contra-lateral graft insertion at the functional M graft had become unusable due to persistent edema for subclavian and superior vena cava occlusion. Another case from functional grafts was accidentally found and was repaired by a short interposition ePTFE re-anastomosis in venous side accompanied by thrombectomy due to severe distal stricture and thrombosis from intimal hyperplasia, approximately 18 months after insertion. Overall advantages and difficulties of the technique are shown in Table 3.

DISCUSSION

The most experienced vascular surgeons who are involved in ESRD and their managing protocol along with hemodialysis experts believe that patient's native veins are the best-protected physiologic conduits for dialysis access as the first step. In complicated patients, attention has been paid to other hemodialysis techniques including arm brachial vein transposition, arm and thigh straight or loop prosthetic accesses respectively as alternatives compare to peritoneal dialysis. Permanent central cuffed catheters are also the last choice that have considered in patients with reduced life expectancy, heart failure, neoplastic patients with destroyed vascular bed by chemotherapy and susceptible patients for ischemic lesions produced by the fistula and limb hypotension means distal hand hypoperfusion (Ferrari, 2005). Although, the considered initial primary patency rate of prosthetic access is competed favorably with brachial-basilic transposition fistulas, but prosthetic materials are usually associated with poor overall patency and high risk of complications (Modarai, 2005 and Zanow, 2012). In addition, long term AVF survival is shown to be worse in obese as a complicating population compared to the non-obese owing to a higher secondary failure (Kats, 2006). Also, obesity has been shown to be a significant risk factor for primary non-functioning and early graft loss resulted in shorter patency of new graft techniques (Naffouje, 2016).Yet, many new types of prosthetic graftssuch as self-sealing Teflon grafts, biological grafts (Dukkipati, 2012), and Hybrid vascular grafts (Anaya-Ayala, 2015), have been tried but generally it has been accepted that neither presumed to have any dominant preference over plain expanded PTFE and straight bridge accesses (Mistry, 2012). Forearm loop graft implantation as the second choice shared by native upper arm AVFs has already been advocated but its considered comparison for complication and thrombosis (Fitzgerald, 2005), rejects the equality versus AVFs. Today, utility of Nitinol surgical clips (D'Cunha, 2004), intra-luminal cover stents (Mistry *et al.,* 2012) and HeRO graft (Katzman *et al.,* 2009) has brought patency advancement solutions but altogether work in limited conditions and do not support the anatomical inducing failures. Still, bridge prosthetic graft access as a choice for "vein-less" and risky patients, especially very obese and diabetic obese remains the preferred conduit, because morbid obese cases and fatty extremities possess failure of suitable matured veins that superimposed variable vascular anatomy make it impossible to achieve certain native accesses. However, considering safe distances for injections and competent hemodialysis, very obese patients with exclusive short length arm are not suitable candidates for any type of straight or loop grafts in our experiences. Patients and staff will increasingly face more difficulties and complications because of usual restricted length of available graft, repeatedly forced one-site injections and worse, over hiding the curved limbs. Thus, under these circumstances, according to the results and flow velocity in comparing between M grafts and control group, we offer the M shape (spiral) graft technique as an alternative suggestion for obese with short arm who require hemodialysis. Upon dialysis stuff and patients questionnaires in trial, needle insertions is easier and counter direction is not needed and more accessible length would be in use exclusively in a short length arm situations. Overall, its status is presented in table 3. From the point of the technique, types of wrapped, stretch, thin wall ePTFE and also mesh covered carbonated polyurethane grafts are not advocated because of non-flexibility and kinking properties.

However, the presented spiral technique and its technical properties needs to be more practiced and evaluated; though, the evaluation of a new surgical procedure for all learning curves may show a number of failures so that it helps to improve the results (Van Glabeke *et al.,* 2005). Our overall experience with the technique attend that one year 44% secondary patency for intervening patients in the study was strongly dependent to diabetes complications and fluctuating blood pressures during dialysis accompanied with short of experience in hemodialysis staff in spite of education in our territory. Conclusively, in this very rare condition, in obese patients who require hemodialysis concomitant with short length arm, especially diabetics, spiral M shape graft procedure may use as the alternative way depending on the surgeon acceptance. It can be efficient principally in females who conventional techniques are not feasible any way. Its creation in the hand of an experienced familiarized vascular or access surgeon would be technically simple and convenient.

Announcement

M shape new technique had already been presented in Iranian annual vascular congress, Mashhad 2006; 16th congress of the Mediterranean League of Angiology and Vascular Surgery, 9-12 June 2006, Crete, Greece, and was accepted in International Society for Vascular Surgery (ISVS) Congress was held on March 9-11, 2012 in Miami, Florida as poster presentation.

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