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Assessment of arteriovenous fistulas made with the oval-shaped anastomosis technique in the end-stage renal disease patients

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ABSTRACT

The end-stage renal disease still holds significant health problems, getting, good, long term functioning vascular access for hemodialysis is our utmost value. Autogenous techniques are generally used for access. There are many surgical methods for getting autogenous access in hemodialysis patients. We aimed to assess the outcomes of the "oval-shaped anastomosis" technique used during the creation of arteriovenous fistulas in patients with advanced renal impairments. We randomly selected and retrospectively examined 52 patients on whom the "oval-shaped anastomosis" technique had been performed. Forty-nine (94%) patency rate in the 52 randomly selected patients on whom we used this mechanism in the first 6 months follow up. The patency and good functioning fistula created for hemodialysis is our priority in advance renal impairment. This technique has been particularly useful in stiff arteriosclerotic arteries, and it provides a more comfortable and clear anastomosis.

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INTRODUCTION

In spite of advances in the transplantation of kidneys and the high in the number of new surgical techniques, the number of patients needs dialysis has been increased (US Renal Data System, 2010; Sung *et al.*, 1997) This raises the magnitude of hemodialysis; and hence, vascular approach in patients with end staged renal disease (ESRD). An effective, safe, and long term hemodialysis therapy needs an arteriovenous fistula (AVF) with completely-functioning vascular access (Jenkins *et al.*, 1980). Many factors affect the long term patency of autogenous AVF. Surgical methods used to play a major role in this condition. In this research, we examined the fistula cases that we constituted as using the "oval-shaped anastomosis" (OSA) technique. Atherosclerosis is a diffuse disease that causes stenosis and occlusions on arteries. Arteriovenous anastomosis has been done for the treatment of occlusive disease or the creation of hemodialysis access in arteriovenous fistula creation. Despite many techniques, diffuse atherosclerosis and inadequate anastomoses are still important reasons for graft failure. We describe in this paper, a simple but important arteriotomy technique for vascular anastomosis on atherosclerotic arteries. The creation of anastomosis on the stiff or calcified artery is one of the challenge situations for surgeons. Specifically, if there is diffuse atherosclerosis and if the endpoint of the plaque is not reachable-like AVF creation for hemodialysis.

The stiffness of the artery keeps the artery like a pipe. Radial forces of the plaque, prevent proper opening on the anastomosis site even after anastomosis. This radial force prevents adequate opening on the artery and may cause early graft failure. The patency of the anastomosis depends on flow. Providing a good flow on the anastomosis site is vital for the fate of the graft. Several techniques have been previously reported for anastomosis (Bharat *et al.*, 2012). All of them could be used; for our technique, we are describing an arteriotomy technique rather than an anastomosis technique.

MATERIALS AND METHODS

This research included AVFs created for hemodialysis therapy in patients with ESRD between October 2016 and January 2018 at the Department of General Surgery in Al-Kafeel super specialty hospital, Kerbala city. We retrospectively examined 52 randomly selected cases; in all patients, we use a radial-cephalic approach, on whom the OSA technique was performed. Application of this technique used without any radiological examination to the patient before surgery. Selection of the patients in a randomized fashion. Thirty-two of the patients were females with a mean age of 52.5 (between 35 and 70 years), and twenty were males with a mean age of 53 (between 30 and 76 years). The distal region of the non-dominant arm was used for the procedure between the cephalic vein and the radial artery. After the assessment of the palmar arcus patency by performing before the anastomosis Allen test. All surgery is done by a single excellent expert cardiovascular surgeon.

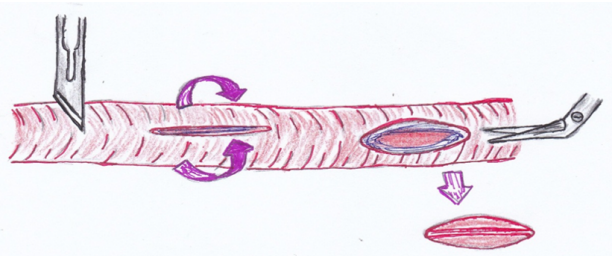

Figure 1: Longitudinal arteriotomy and oval arteriotomy. Oval arteriotomy provides more stable and wide space for anastomosis on atherosclerotic arteries

Surgical techniques

All operation is performed under local anesthesia; we use lidocaine 2% solution and given according to bodyweight about 3-4 mg/kg not exceed total 300mg.Preparation of vein and artery on which the anastomosis was controlled by dissected on the non-dominant arm. After deciding the anastomotic site, we started the surgery after sterilization whole upper limb from fingertips to above mid-arm then draping the area after that we inject local anesthesia (xylocaine solution 2% 5cc) at the area of wrist joint at the radial side. Then small incision 2-3 cm in skin performed then fine dissection, isolation of cephalic vein for 3-5 cm and ligated the vein distally and cut it in an oblique manner to increase the surface area of anastomosis then inject 20-30 cc heparin saline inside the vein and put bulldog clamp on the vein transposed to the anastomosis site. After that radial artery isolated for 2cm and put proximal and distal bulldog clamp on the artery, we have recently modified longitudinal arteriotomy by removing an oval-shaped piece of the artery at the anastomosis site as shown in Figure 2. Firstly, made small slit by blade 11 scalpels, then using micro pot scissor start to make elliptical shape arteriotomy like a hole, so oval arteriotomy has been done by removing small rims from the edges of the longitudinal arteriotomy as present in as shown in Figure 1 and Figure 3, then after measuring the correct length of the vein and sure its alignment starts our end to side anastomosis by 7/0 proline and parachute continuous technique. Before tightening the last stitch releasing the venous clamp for air removal and then finishing the anastomosis. After that releasing of distal and proximal arterial clamp to make sure that good flow passes through the fistula and checking thrill all over the vein and forearm, which indicate successful procedure as shown in Figure 4 and Figure 5, then secure hemostasis and closed the wound correctly layer by layer and loose dressing done. They were allowed to have hemodialysis from their operated arms in the 3rd–4th weeks of their surgery.

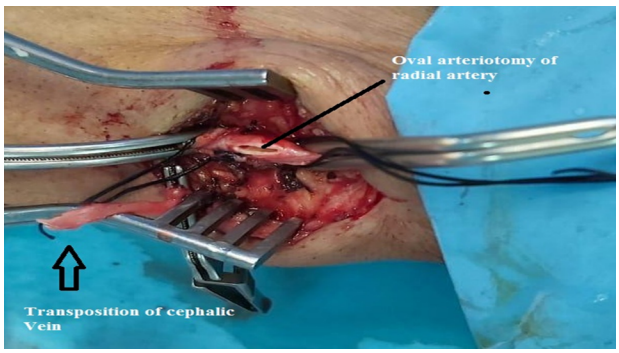

Figure 2: Isolation of radial artery, oval arteriotomy and isolation, and transposition of the cephalic vein

RESULTS AND DISCUSSION

The arteriovenous fistula patency was observed in 49 (94%)out of 52 patients at 6 months after surgery. Thrombosis was seen in 2 cases, and 1

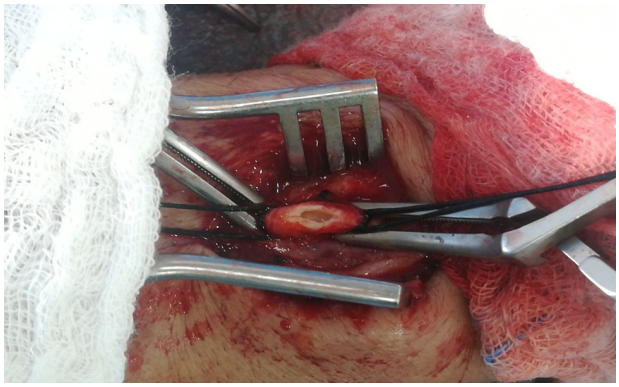

Figure 3: Oval arteriotomy, show a thick edge of atherosclerotic artery

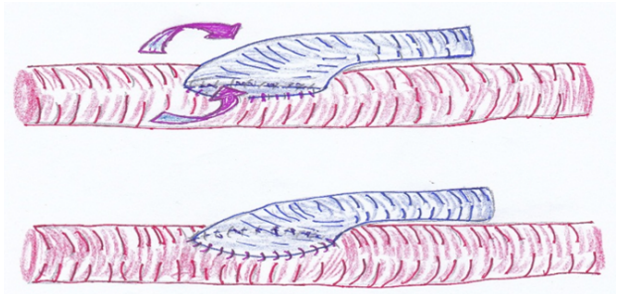

Figure 4: Anastomotic figures for conventional longitudinal arteriotomy and oval arteriotomy. Stiffness of the atherosclerotic artery may not let a wide opening on the arteriotomy site. A wide anastomotic place could be achieved by oval arteriotomy

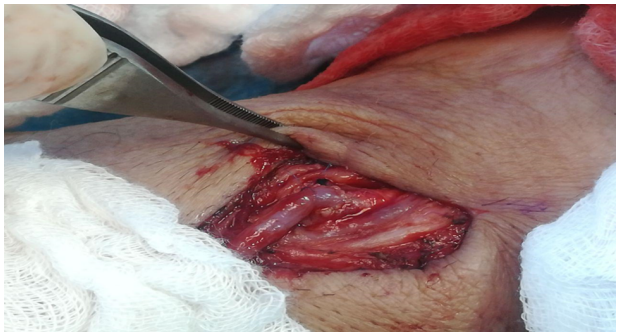

Figure 5: Complete well-functioning anastomosis

patient had a hematoma that was evacuated after diagnosis. Enoxaparin 0.4 was administrated to the patient with radial artery calcification for 3 days postoperatively. Elsewhere no other patients get anticoagulants. The methods that have low infection rates was autogenous arteriovenous fistulas, and lower complication rates and low costs, and applied easily (Sands and Perry, 2002). The frequently preferred to use autogenous fistulas were due to the advantages that they provided. In spite of their advantages, dysfunction rates in the early period in autogenous fistula (in the first 30-day period) reach to as high as 29% (Palder *et al.*, 1985; Fernstrom *et al.*, 1988). This rate is reported to be 79% to 94% in the long term (Bitker *et al.*, 1984; Cassioumis *et al.*, 1992; Kinnaert *et al.*, 1977; Zerbino *et al.*, 1974; Nazzal *et al.*, 1990; Kherlakian *et al.*, 1986). In the standard end-to-side slit technique that we applied during the periods after and before this study, the rate of dysfunction was 25%, which is consistent with results from the literature. Atherosclerosis decrease the arterial elasticity. Decreased elasticity keeps the artery stiffer. Longitudinal arteriotomy may be useful for open the artery, but the stiffness of the artery doesn't let a wide-open place for anastomosis, as in Figure 2. And the blood should pass a narrow and stiff place. Safe, comfortably accessible, and easily implementable intervention routes are required for hemodialysis. The methods of cephalic vein radial artery Figure 1. Schematic diagram of end to side arteriovenous fistula creation with oval technique. We perform these anastomoses; arteriotomy generally applied in an oval form. In our type of anastomoses, the patent of anastomoses rates that created was higher than those made in the slit type. Radial forces of the stiff artery decrease blood flow from a longitudinal arteriotomy site. Theoretically, oval arteriotomy provides a wider place for the anastomosis and better flow. Figures 1 and 3. The vascular punch aortotomy has been using for the proximal anastomosis of coronary artery bypass operations. A similar technique also was described for microvascular anastomoses. (Hallock and Rice, 1996) Geoffery et al. proposed a 1.5 mm micro punch for small size arteriovenous anastomoses. In anastomoses of slit type arteriotomy done at the proximal upper extremities, (Brescia-Cimino; snuff-box) patency rates in the first 6 postoperative months are reported as 66% and 70%, respectively (Fernstrom *et al.*, 1988; Nazzal *et al.*, 1990; Miller *et al.*, 1999; Brimble *et al.*, 2002). The patency rate in our study at the end of the first 180 days was 94%. (49/52) patients. At the early stage, thromboses that emerge in fistulas negatively affect treatment. Also, at the early stage thromboses caused by many factors include the surgical technique used, arterial calcification, vasospasm, unpropitious artery and vein diameters (below 1,5–2 mm), high vein pressure, and external pressure (Kherlakian *et al.*, 1986; López-Monjardin and Peña-Salcedo, 2000). While doing the surgical technique, there were many problems, the troubles that can emerge included irregularity in the alignment of vascular walls during anastomosis, intima injured induced iatrogenically, the rear wall suturing accidentally, mismatch diameter between the vein and the artery in question, tissue penetration in between the sutures while plac-

ing the sutures, and a stretched anastomosis. Also, the decrease in the blood flows play apart from these factors, through the shunt in the early stage is another significant reason for the dysfunction. Usually, the hypotension is the main cause for dropping flow is that it develops during dialysis and vasospasm. So higher pressure requirements to maintain usual slit arteriotomy patency (Sen *et al.*, 2006). Hypotension leads to that arteriotomy lips can come next to each other in slit type, which may lead to a further decrease in the flow and fistula flow cut off, in cases in which slit arteriotomy is used. In oval-shaped anastomosis, so cannot come arteriotomy lips exactly next to each other and thus prevented it is dysfunction, as shown in Figure 2. In the anastomoses of end-to-side, the success rate generally depends on the suitable implementation of arteriotomy at the correct location. A sudden change in vessel diameter can result in turbulence, which may cause thrombosis (Sen *et al.*, 2006; Dotson *et al.*, 1998). Also, vasospasms decrease in end-to-side anastomoses, cessation, or flow drop associated with vasospasm might be prevented in OSA as well (Dotson *et al.*, 1998; Verhelle and Heymans, 2005; Yoleri and Songur, 2002). Furthermore, the suturing technique by incisions made is also important in thrombosis formation. Sutures can be comfortably placed with the oval technique. Further, happen, and, as the sutures are available under easy-to-view status, accidental suturing of the real wall is prevented. Also, hematomas postoperative are thus prevented and avoid of dysfunction of fistula (Sen *et al.*, 2006). The region that is bifurcate is straighter in the oval technique as compared with the slit technique, which reduces turbulent flow. The larger anastomosis surface in the OSA technique compared to other techniques also increases the flow passing through the fistula (Sen and Hasanov, 2008). The sudden change of diameter plays a major cause of turbulence that emerges in an anastomosis site. This technique mimics the natural branching of the arteries. If a branch of the artery is cut off from the root, the space of the branching area will be seen. Because of the shape of the removed piece of the arteriotomy place, this technique could be named as 'oval arteriotomy.'

CONCLUSION

We believe that the technique we have described here is simple, practical, and efficient for anastomoses grafts over atherosclerotic arteries. With its flow-related and hemodynamic advantages, oval-shaped arteriotomy is an effective method in reducing fistula dysfunction.

Declarations

Ethical consent has been taken from all patients.

Consent for publication

Consent has been taken from the institution and the patients.

Material and data

The data used and/or resolved during the current study is ready from the corresponding author on need.

Competing interests

All authors stat they don't have any conflict of interest.

Funding

Authors declare not received any funds from any source.

Authors' contributions

1. The corresponding author accepts total responsibility for the study and/or the attitude of the work, had access to the information, and planned the decision to publish, revised the article grammar adjusted ideal content and final agreements of the version to be published.

2. Has conceptualized, and designed the study and also the surgeon who performed arterio-venous fistula surgery, gain interpretation and analysis of data.

3. Writing assistance, collected the data, follow up the patients.

4. Vascular surgeon assist in surgery and data collection.

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