ORIGINAL RESEARCH PAPER

Plastic Surgery

RETROSPECTIVE ANALYSIS OF 4500 AV FISTULAS AS VASCULAR ACCESS FOR HAEMODIALYSIS.

KEY WORDS: AVF, hemodialysis, HD, end to end anastomosis

Dr. Ajitsingh P Chadha M.S (General Surgery),M.Ch(Plastic Surgery),Associate Professor Department of Plastic Surgery,Krishna Institute of Medical Science and Research Centre,Karad

Dr. Nehadeepkaur Ajitsingh Chadha* General Surgery Resident,* Corresponding Author

ABSTRACT

This study describes our experience of arteriovenous fistula (AVF) from Jan.1992 to Sept 2015. A total of 4500 AVFs were created in 4200 patients.

All patients were operated by single surgeon .The youngest patient was 8 year old and the oldest was 90 year old. 95% of the patients were operated at wrist with end to end anastomosis of redial artery and dorsal branch of cephalic vein. Remaining 5% were operated with high radiocephalic end to end anastomosis. Primary patency was 95% for the AVFs operated at wrist. Patency rate for high forearm radiocephalic fistulas with end to end anastomosis was 99%. Total complications were found in 10 % cases.The end to end anastomosis seems to be preferable to other techniques.

INTRODUCTION:

National Kidney Foundation has described "Fistula first" and AVF is considered as 'Gold standard . A shift in the treatment of haemodialysis (HD) patients occurred when James E Cimino noted that AVFs caused by trauma in Korean War veterans did not have significant effect on their health. The first surgical creation of AVF for hemodialysis was performed in 1965 by Brescia, Cimino and Co–workers at New York, a real breakthrough in the field of vascular access[1].

The quality of the vascular access for hemodialysis should be suitable for repeated puncture and allow fast blood flow rate for high dialysis with minimum complications. Therefore for long term functioning AVFs needs a well trained surgeon to create it and enough time should be allowed for maturation .The dialysis staff must be well versed in cannulation of the AVF.

MATERIAL AND METHODS:

Some rules should be considered before doing AVF.

1. Good history taking with h/o hypertension, cardiac disease, peripheral ischemia, stroke, diabetes, history of previous central or peripheral catheterisation, angiography, angioplasty.
2. Clinical examination of the veins and arteries of both upper extremities, Allen's test, if required doppler studies also to be done.
3. After diagnosis is made, avoid pricks on both upper extremities in the areas vital for AVF construction (save veins)
4. Vascular access should be planned 3 to 4 months prior to the expected start of HD
5. It is indispensable for the nephrologists to have some knowledge concerning hemodynamics of AVF and some aspects of surgical techniques. In addition the vascular surgeon should also become familiar with dialysis related mechanisms.
6. Normally these operations are considered as "simple "procedures.This is big misunderstanding because these operations require high technical skills and experience.
7. AVFs should not be posted at the end of the surgery list as results may not be good.
8. Selection of the vessels and site for the anastomosis in some way resembles chess. One must always anticipate the next two or three moves and must consider what possibilities remain after failure.
9. As far as possible non dominant hand was selected.
10. Location: Construction of AVF is possible at various locations depending upon quality of veins and artery .The first anastomosis should be positioned as far in the periphery as possible. In case of failure, proximal anastomosis can be done.
11. Incision: Longitudinal incisions are preferred than transverse across the joint. 'S' shaped incision may be taken.
12. All operations were done under local anesthesia using magnifying loup and following microvascular techniques.
13. Handling of tissue is very important. Vein must be mobilized and adopted to the artery. It is important to limit the length of the mobilized vein to absolute minimum .Mobilization implies trauma and devascularisation of the venous wall secondary to interruption of vasa vasorum and removal of adventitia. This leads to scar formation. This is particularly true after creation of anastomosis. High flow rate and high pressure further increase the risk of scar formation and in addition aggravate the risk of torsion and kinking.
14. All patients were operated with end to end anastomosis of radial artery and dorsal branch of cephalic vein. When proper vessels were not available then proximal radiocephalic end to end anastomosis was performed.
15. All anastomosis were done with 7–0 or 8-0 prolene with interrupted sutures.
16. Position of artery and vein anastomosis was done at an angle of $25^{0} \pm 5^{0}$ ensuring that while closure of incision there should not be pressure over AVF.
17. Spasm was treated by application of papavarine.
18. Antibiotics and anticoagulants were not used.
19. All patients were operated as outdoor patient.
20. Post operatively they were asked to do exercise with soft ball.They were advised to watch for bleeding, not to sleep on operated area under the head and avoid trauma to operated area.
21. All patients follow up was done by Nephrologist.

Total no. of cases-4200.
Total no. of fisulas-4500.

Youngest patient was 8 years old and eldest was 90 years old.
Sex distribution – Male -3360. (80%) Female - 840. (20%).

Associated diseases – Diabetes (DM) in 1680 cases. (40%)
Hypertension (HTN) in 1200 cases. (30%)
Both DM & HTN in 630. (15%)

All patients were operated above the wrist with end to end anastomosis of radial artery and dorsal branch of cephalic vein.

In 95% cases thrill was felt on the operating table.

Primary failure rate was 5%.

All cases of failure were operated with high radiocephalic end to end anastomosis Thrill was felt in 99% cases on operating table.

COMPLICATIONS

Sr. No	Complications	Stolic R	Azman ATES	Sammy El-Benna	Gordon	Our series end to end
1.	Thrombosis	17.25 %	30.4 %	33.7%	ETE 7% ETS 2.3% STS 5.56%	5 %
2.	Aneurysm	5.6%	4%	3.9 %	--	0.59 %
3.	Steal	2.8%	3.1%	3.7 %	--	--
4.	Hematoma	--	6.1%	--	--	2 %
5.	Infection	2-3 %	3.3 %	--	--	2.38%

Gordon reported total no Complications - End to End -62.5%
End to side-10.76%
Side to side -18.8 %
In our series total number of complications -10%

Patency Rate

Patency rate	1Year	2Year	5Year	10Year
G.Simmon[6]-End to end anastomosis	75.5%	-	54.5%	30.7%
Sammy Al –Benna[7]-	70%	-	52.1%	-
Gordan[8]-a) end to end b) end to side c)side to side	-	52.5% 89.23% 81.1%	-	-
Tadeusz Mularczyk [9]et al	64.8%	-	56.5%	-
PPGM Rooijens [28]et al	62.5%	-	-	-
C.Bonaluni[12] Anatomical snuffbox (177 AVFs)	-	83.1%	(6.5yrs) 46.3%	-
National Kidney Foundation[13]2001	70%	60%	(3yrs) 50%	-
Stanziale R[22]et al a)end to end b)end to side	80% 85.%	-	-	-
Markus Fokou[25]et al (628 AVFs)	76%	51%	-	-
G Simmon[6] et al (140 AVFs)end to end	77.3%		36.3%	18.3%
Our Series 4800 AVFs	90%	85%	70%	-

DISCUSSION

The term dialysis (coming from Greek) means a process of separation of substances using their different ability through semi permeable membrane. Thomas Graham was first to use this term in 19th century. The Dutch physician William Kolff was first to perform a dialysis in a patient suffering from uremia in 1943. The three types of vascular access used for most dialysis patients are AVF, grafts and catheters. Autogenous AVFs have been shown superior to prosthetic graft or catheter access in terms of patient morbidity or mortality.

Brescia and Cimino described side to side AVF in 1966. One year later end to end anastomosis was published followed by artery side and vein end in 1968. Any surgeon involved in creating vascular access must be familiar with these different types of anastomosis. Experience, planning, skill and patience are prerequisites of success .The surgeon must be aware of anatomical ,physiological and mechanical principles underlying the procedure and this has to be combined with manual skill, experience and creativity .There is no place of minor error or compromise.

Arterial Requirement For AVF

- Pressure difference < 20 mm of Hg both arms.
- Patent palmer arch (Allen test).
- Arterial lumen diameter ≥2mm.

Venous Requirement For AVF:

- Luminal diameter >2mm at anastomosis and absence of proximal blockage for free flow.

Ideal AVF Should Fulfill Following Requirement:

- Adequate blood flow to support dialysis (300ml/min or more.)
- Adequate maturation at the end of 6 weeks for frequent cannulation.
- Depth shouldn't be more than 6 mm.
- Accessible anatomical location.
- Relatively straight segment for cannulation.

Today the preferred techniques for AVF anastomosis are the original side to side or side of artery and end of the vein. The side to side anastomosis is reliable technique. If the distal venous end is open, venous hypertension occur in most of the patients. Such venous hypertension can be avoided by ligation of distal venous limb after the creation of the side to side anastomosis, in other words functional side to end anastomosis is created. End to end anastomosis has gained widespread acceptance by the first half of seventies but technical problems arose because of the difference in the lumen of the artery and of the vein. With the increasing number of patients with arterial problems, diabetics and elderly patients chances of peripheral ischemia are always there. Technically end to end anastomosis needs skill and patience.

In this series all patients were operated with end to end anastomosis above wrist using radial artery and dorsal branch of the cephalic vein. Not a single patient had peripheral ischemia, venous hypertension or steal syndrome .Compared to other series patency rate was much higher (95%) and complications were much less(10%).Surendra Shenoy et al collected data of 1385 vascular access anastomosis (clipped or sutured) from 17 hospitals and dialysis centres. They found access patency significantly improved performing end to end anastomosis.

Current literature supports patient factors such as increasing age, presence of diabetic disease, peripheral vascular disease, pre-dialysis hypotension and vessel characteristics as directly influencing AVF patency .Vessels of small calibre (<2mm) or demonstrating reduced distensibility are unlikely to create a functional AVF. Current evidences don't support altered patency due to sex or raised body mass index (<35 kg /m^2).Factors such as early reference for AVF, pre-operative ultrasound , mapping, use of vascular staples and intra operative flow measurement affected AVF patency ,but the use of medical adjuvant therapies did not . Noval techniques of infrared radiotherapy and topical Glyceryltrinitrite are possible future strategies to increase AVF patency.

The common complications of fistula are bleeding, seroma formation, infection, thrombosis, venous hypertension, stenosis, steal syndrome, aneurysm formation , neuropathy and ischemia. The radial artery normally provides a flow rate of 20-30ml/min & immediately after maturation flow rate reaches 300ml /min. Even minor normal narrowing will eventually translate to late stenosis .So not only the early but late failure also reflect on the quality of vascular surgeon. Some mechanical factors like tissue handling puncture technique and sheer stress on the vascular endothelium are also responsible for failure of fistula .Several medical factors have also been identified like stasis, hypercoagulopathy ,medications ,red cell mass ,genotype ,polymorphism of transforming growth factor B1 and Methylene tetrahydrofolate reductase. A number of indicators for fistula thrombosis have been discussed in the literature such as MCP1 lipids,

homocystiene, soluble E selection and soluble EPCR .Atherosclerosis might also be contributing to late stenosis .Simple drop in the blood pressure during dialysis lead to stasis and closure of AVF.

According to KDDQI guidelines, AVF maturation is considered clinically successful if six weeks after surgery the fistula support a flow of 300ml /min. The exact cause of maturation failure is not known, but impaired outward remodeling as well as intimal hyperplasia are both considered to contribute [21] .After fistula creation healthy vein has the potential for successful outward remodeling .Adequate maturation may be partially hindered by CKD induced pre-existing vasculopathy such as intimal hyperplasia (IH) .Net result of IH and outward remodeling may determine ultimate luminal calibre. If IH imbalances outward remodeling this could result in stenosis and fistula failure. Milind Nikam et al [15] presented study of AVF placement using optimum device that showed its effectiveness with high maturation. G M Kazemzaden et al [19]showed better patency(70%) in patients who are under dialysis in comparison with (43%)who are not under dialysis. The mechanism of haemodialysis effect on AVF is not known & needs further study.

Lot of studies have been done on long term patency with angle of anastomosis to prevent stenosis by Janaina et al. The angle of anastomosis should be $25^{0}\pm 5^{0}$. In this study anastomosis angle of $25^{0}\pm 5^{0}$ was maintained.

Bed side diagnosis of critically low blood flow through AVF

1. Auscultation: high bruit at the site of anastomosis.
2. Hand elevation test: Collapse of the post-stenotic venous segment and persistent congestion of pre-stenotic segment.
3. Prolonged bleeding after removal of needle from the puncture site.

Once reduced flow and stenosis are documented, one has two alternatives, Interventional Radiology or Corrective Surgery.

Current Procedures Available:

Percutaneous transluminal angioplasty
Endovascular stent
Surgical intervention
Fish oil
Anti-coagulant therapy
Anti-platelets.
Angiotensin converting enzyme inhibitors

Other Treatment Options(future,experimental)

Radiation
Vascular endothelial factors.
Gene Therapy
Recominent elastase PRT 201
Endovascular balloon catheter with sheathed microneedle used to deliver the drug –perivascular polymers.
Circulating vascular progenitor cells.
Photodynamic therapy.
Cryoplast

In our series all patients with stenosis were operated for high forearm radio-cephalic end to end anastomosis .The potency rate was 99%.

Steal syndrome is caused by a decrease in distal blood perfusion due to proximal preferred blood flow outlet through vascular access vein with less resistance than the distal arterial bed.

Grade 0 - No steal
Grade 1 - Mild cold extremity with no symptoms
Grade 2 - Moderate intermittent ischemia only during dialysis/claudication.
Grade 3 - Severe ischemia /pain /pain at rest /tissue loss.

In the series not a single case of Steal Syndrome was found.

Aneurysm was found in (0.59 %) of cases where proximal AVF was done with 99% patency.

Al Jaishi et al studied 62 cohorts published from 2000 to 2012, total 7393 fistulas, primary failure rate average was 23%. C. Bonaluni et al presented series of 177 AVFs out of which 10% fitulas failed immediately.

Markus Fokoli et al presented series of 621 AVFs, out of which 14.69% failed to mature.

In our series primary failure was 5%.

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