Original Article

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Internal Medicine Section

Comparison between the Techniques of Radiocephalic Arteriovenous Fistulas for Haemodialysis: A Retrospective Analytical Study

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ABSTRACT

Introduction: Chronic Kidney Disease (CKD) has become a major health issue worldwide. CKD patients require Renal Replacement Therapy (RRT) throughout their life. Haemodialysis is one of the options for RRT. Arterio-Venous Fistula (AVF) creation is required for haemodialysis. The radiocephalic fistula is the initial option for creating vascular access. Fistula can be created by anastomosing cephalic vein to radial artery either by End-To-Side (ETS) or Side-To-Side (STS) techniques.

Aim: To compare the efficacy rate of radiocephalic AVF using ETS or STS anastomotic methods.

Materials and Methods: This was a retrospective analytical study conducted at SDM college of medical sciences and hospital, Dharwad from March 2017 to February 2020. A total of 43 CKD patients were enlisted for the above duration from the hospital records. These patients were included in the study since they underwent radiocephalic AVF creation. AVF creation at other anatomical sites for rest of the CKD patients was excluded. Out of 43 patients, 24 of them underwent ETS technique and 19 STS technique; 15 patients from the former group and 17 from the latter were followed-up for a period of three months. Eleven patients were lost to follow-up. Demographic variables were analysed with frequency, mean and standard deviation. Its association with two different operative techniques was analysed using Fisher's-exact test. Outcome of the two operative procedures was analysed using Student's t-test.

Results: Effectively 15 patients from ETS group and 17 from STS group were compared. Three (20%) in ETS group and 5 (29.41%) in STS group had primary failure. Mean of maturation time in weeks in ETS group was 4.73±2.73 weeks and in STS group was 5.29±3.75 weeks. Three months patency rate in ETS group was 12 (80%) and in STS group was 12 (70.58%). Student's t-test was performed comparing the above parameters and no statistical significance was noted.

Conclusion: Comparison of two techniques of radiocephalic AVF creation proves that both the techniques are beneficial with no superiority of one over other.

Keywords: Chronic kidney disease, End stage renal disease, End-to-side technique, Side-to-side technique

INTRODUCTION

Chronic diseases have become a major cause of morbidity and mortality round the globe. Initially considered to be a health issue only in developed nations, 4 out of 5 chronic disease deaths now occur in developing nations [1]. The increase in prevalence of CKD progressing to End Stage Renal Disease (ESRD) and the subsequent financial burden on RRT [2,3] has highlighted the importance of CKD and its risk factors. ESRD patients depend on RRT throughout their life. RRT is either through renal transplant, peritoneal dialysis or through haemodialysis. Haemodialysis is the major mode of RRT [4]. Following Scribner's shunt in 1960, creation of subcutaneous AVF of radial artery with cephalic vein was described by Cimino JE [5]. The radiocephalic fistula is the initial option for creating vascular access if not contraindicated. As radiocephalic fistula being the distal anastomosis, fewer vascular complications are associated; this also promotes proximal venous development which aids in future vascular accesses. A 15% early thrombosis rate is associated with radiocephalic fistula despite of its continued efficacy [6]. The anastomosis can be performed either ETS or STS fashion. This was a single center retrospective observation study comparing the two techniques of radiocephalic AVF in terms of the time of maturation and the three month patency of the created AVF.

Aim of the study was to compare the efficacy rate of radiocephalic AVF using ETS and STS anastomotic methods; ETS and side to side technique with respect to primary failure of AVF, time of maturation of the fistula and the patency of the fistula at three months.

MATERIALS AND METHODS

This was a retrospective analytical study done at SDM College of Medical Sciences and Hospital, Dharwad in patients who underwent radiocephalic AVFs from March 2017 to February 2020. Ethical concerns were addressed and all the patient data were kept anonymous.

Data collected from the hospital records included patient details like age, sex, date of surgery, aetiology of ESRD, presence of co-morbidities like hypertension and diabetes mellitus, personal habits like smoking and tobacco chewing.

Clinical examination in terms of caliber of cephalic vein and condition of radial artery vessel wall was noted. Patients with inadequate clinical findings underwent Doppler ultrasound scan. Cephalic vein and radial artery diameter were noted in patients who underwent pre-operative doppler ultrasound scan. Hand dominance of the patient was noted and the surgery was preferred on the non-dominant hand. In cases with previous surgery on one limb and extensive venous thrombosis opposite limb was chosen.

All the above-mentioned details were extracted from patient's case file. The data was then categorised into two groups based on the type of anastomosis - STS anastomosis with distal vein ligation technique and the end cephalic vein to side radial artery anastomotic technique.

During this period, 43 patients underwent radiocephalic arteriovenous fistula. Nineteen patients underwent STS anastomosis technique and 24 ETS anastomosis technique. Follow-up was obtained in collaboration with Nephrology and dialysis unit staff. Loss to follow-up was accounted in two patients from STS group and eight from ETS group. One patient from ETS anastomosis technique group died due to multi-organ failure prior to expected week of fistula maturation which was unrelated to creation of AVF. Seventeen patients from STS anastomosis technique and 15 patients from ETS anastomosis technique were compared with respect to primary failure of AVF, three months fistula patency and maturation of the fistula.

For the study, fistula patency at three months was defined as presence of palpable thrill or audible bruit on auscultation. Maturation of fistula with successful cannulation was defined as ability of vascular access to deliver a flow rate of 350-400 mL per minute with no access recirculation to maintain a treatment time of less than 4 hours [7-9].

Surgical Technique

As a protocol, all patients are operated under brachial plexus block with tourniquet control. Patient is placed supine with upper limb to be operated at 90 degree abduction. Curvilinear incision measuring 3-3.5 cm made on the radial border of distal 3rd of forearm 1 cm proximal to the wrist crease. Incision is placed in between the cephalic vein and the radial artery.

Dissection performed under loupe magnification to isolate cephalic vein and radial artery and both the vessels brought in close proximity. In ETS anastomosis technique, the distal side of the cephalic vein ligated, proximal side clamped using atraumatic vascular clamp, vein cut between the vascular clamp and ligature, arteriotomy performed and anatomosis of proximal cut end of the vein and artery using 9-0 nylon in continuous running fashion. In side to side anastomosis technique following clamping of distal and proximal venous sides venotomy performed, arteriotomy done and anastomosis performed employing back wall first technique which is described by Tellis VA et al., [10]. Nylon 9-0 is the suture material used. Tourniquet is deflated and thrill is palpable in most of the cases, in cases where thrill is not palpable or bruit not heard but good venous filling noted, anti-coagulation is started in postoperative period following nephrology consultation. Thorough haemostasis is achieved and the skin incision is closed in two layers. Non-compressive dressings applied. Patient is advised not to apply pressure over the operated site, not to allow blood collection from the operated upper limb. Hand exercises using a soft ball are demonstrated and patient is asked to follow the same in postoperative period. Wound dressing is removed on second postoperative day and patient is discharged.

STATISTICAL ANALYSIS

IBM SPSS (statistical package for social sciences) version 20 was used to analyse the data. Demographic variables were analysed with frequency, mean and standard deviation. Its association with two different operative techniques was analysed using Fisher's-exact test. Outcome of the two operative procedures was analysed using Independent Student's t-test.

RESULTS

In the present series (after excluding lost to follow-up patients and death of patient) a total of 32 patients' data was analysed. Of them, 15 (46.87%) underwent ETS technique and 17 (53.12%) STS technique. The mean age of patients among ETS group was 48.7±17.2 years and STS group was 36±12.5 years. Males constituted the majority of the study population {13 (86.7%) and 13 (76.5%) for ETS and STS groups, respectively}. Non-dominant hand was the preferred site for the AVF creation [Table/Fig-1]. Hypertension contributed majorly as an aetiological factor among both the groups [Table/Fig-2].

Variable	ETS technique N (%)	STS technique N (%)	p-value
Age in years			
10-20	1 (6.7)	2 (11.8)	0.121
20-30	3 (20)	5 (29.4)	
30-40	0 (0)	4 (23.5)	
40-50	3 (20)	4 (23.5)	
50-60	3 (20)	2 (11.8)	
60-70	4 (26.7)	0 (0)	
70-80	1 (6.7)	0 (0)	
Sex Distribution			
Female	2 (13.3)	4 (23.5)	0.461
Male	13 (86.7)	13 (76.5)	

[Table/Fig-1]: Demographic features.
p-value calculated by Fisher's-exact test; p<0.05 to be considered significant; ETS: End to side anastomosis; STS: Side to side anastomosis

Variable	ETS technique N (%)	STS technique N (%)	p-value
History of hypertension			
Non-hypertensive	0 (0)	1 (5.9)	1.000
Hypertensive	15 (100)	16 (94.1)	
History of diabetes			
Non-diabetic	8 (53.3)	14 (82.4)	0.128
Diabetic	7 (46.7)	3 (17.6)	
Chronic glomerulonephritis			
No	11 (73.3)	13 (76.5)	1.000
Yes	4 (26.7)	4 (23.5)	
Congenital kidney diseases			
No	13 (86.7)	14 (82.4)	1.000
Yes	2 (13.3)	3 (17.6)	
Smoking habit			
No	13(86.7)	17 (100)	0.212
Yes	2 (13.3)	0 (0)	
Tobacco chewing habit			
No	12 (80)	17 (100)	0.092
Yes	3 (20)	0 (0)	

[Table/Fig-2]: Aetiological factors for End Stage Renal Diseases (ESRD).
p-value calculated by Fischer's- exact test; p<0.05 to be considered significant; ETS: End to side anastomosis technique; STS: Side to Side anastomosis technique

Out of 15 patients in ETS anastomosis technique, 3 (20%) had primary failure. Maturation time of AVF ranged from 4 to 8 weeks, with a mean of 4.73 weeks (±2.73). Three months patency was noted in 12 (80%) patients. Out of 17 patients in STS anastomosis technique, 5 (29.41%) had primary failure. Maturation time of AVF ranged from 6 to 10 weeks with a mean of 5.29 weeks (±3.75). Three months patency was noted in 12 (70.58%) patients.

The two operative techniques were compared by performing Independent Student's t-test for primary failure (p=0.555), maturation time (p=0.115) and three months patency rate (p=0.384) [Table/Fig-3].

Variables	ETS	STS	p-value
Primary failure [n(%)]	3 (20)	5 (29.41)	0.555
Mean maturation time (mean±SD), weeks	4.73±2.73	5.29±3.75	0.115
Three-month patency rate [n(%)]	12 (80)	12 (70.58)	0.384

[Table/Fig-3]: Comparison of variables and outcome.
p-value calculated by independent student t-test; p<0.05 to be considered significant

DISCUSSION

Creation and maintenance of an adequate vascular access is an important factor for successful haemodialysis. Multiple vascular accesses may be required for haemodialysis patients in their lifetime as the life expectancy of these patients has improved in recent years.

Radiocephalic fistula was described by Cimino JE [5]. The main drawback of AVF is the significant rate of primary failure which is 20-50% [11-13]. Although there is consensus in terms of location of primary AVF formation at wrist [14,15] there is definitive dearth of evidence supporting the use of STS anastomosis technique and ETS anastomosis technique.

Primary failure rate in the present study in ETS group was 20% and STS group was 29.41% with an overall primary failure rate of 25%. Majority of the large volume centres report primary failure rate of 15-30% for radiocephalic AVF [16,17]. The incidence reported for primary failure in the literature varies from 9% [18] to 40% [19] and results in the present study with 25% primary failures were comparable. Definition of primary failure is absence of well-developed veins accessible for dialysis at 12 weeks after fistula surgery [19]. The primary failure rate of ETS group verses STS group was not statistically significant (p=0.555).

In the present study, fistula survival rate was noted at three months which was 80% in ETS anastomosis group and 70.58% in STS anastomosis technique group. Khan MW et al., reported an overall survival rate of 89.3% in ETS anastomosis group and 85.1% in STS anastomosis group (p=0.253) [20]. Cassioumis D et al., reported that early patency rates did not differ significantly between the ETS group (90%) and the STS group (88%) [21]. In present study, it was noted that there was no statistical significance (p=0.384) in three month patency rates of ETS versus STS groups. Further follow-up of the cases are yet to be done. However, there is evidence which states that the likelihood of overall thrombosis leading to failure of AVF is less than 10% if AVF does not thrombose and fail within first three months of its creation [22]. Hence, if early thrombosis leading to primary failure of AVF is avoided, the primary fistula patency increases and the arterialised vein shall be suitable for early cannulation/early maturation [23].

In patients undergoing haemodialysis, 60% use catheters for haemodialysis access and one of the substantial reasons for prolonged intravascular catheter use is delay in maturation of arterialised vein [24]. Catheter related bacteremia rates range from 2.4-5.5/1000 catheter days, thus increasing the morbidity, increased stay in the hospital and overall cost [25]. When catheter remains in-situ for six months the rate of infection increases up to 48%. Creation of autologous AVF with early maturation allowing nominal use of tunneled catheters will have a large impact on patient morbidity [26]. This signifies the importance of early maturation of AVF. The time for maturation of arterialised cephalic vein in present study ranged from 4 weeks to 10 weeks with a mean of 5.03 weeks (±3.27).

Comparing the results of both the groups with two different methods of AVF creation during a follow-up period of three months, we opine that there is no significant difference between the two techniques with respect to primary failure rate, maturation time and three-month patency rate.

Limitation(s)

It was conducted retrospectively and the sample size was relatively small. Period of follow-up was short. The possibility of reaching different results with longer duration follow-ups cannot be ruled out and this extra follow-up time will surely help reaching a better insight regarding the AVF patency and access longevity.

CONCLUSION(S)

This study compared two separate techniques of radiocephalic AVF creation. All the parameters evaluated and their relations revealed no statistical significance between the two. Autologous radiocephalic AVFs at the wrist continues to be the first choice of vascular access and both ETS and STS techniques of anastomosis have proven to be beneficial in creation of AVF with no superiority of one over other.

REFERENCES

[1] World Health Organization: Preventing Chronic Disease: A Vital Investment. Geneva, WHO, 2005.
[2] Grassmann A, Gioberge S, Moeller S, Brown G. ESRD patients in 2004: Global overview of patient numbers, treatment modalities and associated trends. Nephrol Dial Transplant. 2005;20(12):2587-93.
[3] Center for Disease Control and Prevention (CDC): Prevalence of chronic kidney disease and associated risk factors-United States, 1999-2004. MMWR Morb Mortal Wkly Rep. 2004;56(5):161-65.
[4] Niyyar VD, Wasse H. Vascular mapping: Does it help to maximize fistulae placement? Adv Chronic Kidney Dis. 2009;16(5):316-20.
[5] Cimino JE. Historical perspective on more than 60 years of hemodialysis access. Semin Vasc Surg. 2007;20(3):136-40.
[6] Rooijens PP, Tordoir JH, Stijnen T, Burgams JPJ, Smet De, Yo TI. Radiocephalic wrist arteriovenous fistula for hemodialysis: meta-analysis indicates a high primary failure rate. Eur J Vasc Endovasc Surg. 2004;28(6):583-89.
[7] Lok CE. Fistula first initiative: advantages and pitfalls. Clin J Am Soc Nephrol. 2007;2:1043-53. doi: 10.2215/CJN.01080307
[8] Shenoy S. Innovative surgical approaches to maximize arteriovenous fistula creation. Semin Vasc Surg. 2007;20:141-47. doi: 10.1053/j.semvascsurg.2007.07.005
[9] Iyem H. Early follow-up results of arteriovenous fistulae created for hemodialysis. Vasc Health Risk Manag. 2011;7:321-25.
[10] Tellis VA, Veith FJ, Soberman RJ, Freed SZ, Gliedman ML. Internal arteriovenous fistula for hemodialysis. Surg Gynecol Obstet. 1971;132(5):866-70.
[11] Allon M, Robbin ML. Increasing arteriovenous fistulas in hemodialysis patients: problems and solutions. Kidney Int. 2002;62(4):1109-24.
[12] Rayner HC, Pisoni RL, Gillespie BW, Goodkin DA, Akiba T, Akizawa T. Creation, cannulation and survival of arteriovenous fistulae: Data from the dialysis outcomes and practice patterns study. Kidney Int. 2003;63:323-30.
[13] Lok CE, Oliver MJ, Su J, Bhola C, Hannigan N, Jassal SV. Arteriovenous fistula outcomes in the era of the elderly dialysis population. Kidney Int. 2005;67(8):2462-69.
[14] Gilmore J. KDOQI clinical practice guidelines and clinical practice recommendation se 2006 updates. Nephrol Nurs J. 2006;33:487-88.
[15] Sidawy AN, Spergel LM, Besarab A, Allon M, Jennings WC, Padberg Jr FT. Society for Vascular Surgery. The society for vascular surgery: Clinical practice guidelines for the surgical placement and maintenance of arteriovenous hemodialysis access. J Vasc Surg. 2008;48(5 Suppl):2S-25S.
[16] Haimov M, Baez A, Neff M, Slifkin R. Complications of arteriovenous fistulas for hemodialysis. Arch Surg. 1975;110(6):708-12.
[17] Al Shohaib S, Al Sayyari A, Waness AA. Hemodialysis angioaccess choice and survival in a tertiary care Saudi Arabian center from 1993 to 2004. Nephrourol Mon. 2011;3:69-73. doi: http://dx.doi.org/10.18203/2349-2902.isj20181133
[18] Bakari AA, Nwankwo EA, Yahaya SJ, Mubi BM, Tahir BM. Initial five years of arterio-venous fistula creation for hemodialysis vascular access in Maiduguri, Nigeria. Internet J Cardiovasc Res. 2007;4:1-6.
[19] Huijbregts HJ, Bots ML, Wittens CH, Schrama YC, Moll FL, Blankestijn PJ. Hemodialysis arteriovenous fistula patency revisited: Results of a prospective, multicenter initiative. Clin J Am Soc Nephrol. 2008;3(3):714-19.
[20] Khan MW, Khan MM, Qadir I, Ch ZA, Liaquat H. Comparative study of efficacy of ETS with STS arteriovenous fistula in patients on hemodialysis. Pakistan Journal of Medical and Health Sciences. 2015;9(1):235-38.
[21] Cassioumis D, Fatouros MS, Siamopoulos KC, Giannoukas AD. Shortand long-term evaluation of arteriovenous fistulas for chronic hemodialysis. Microsurgery. 1992;13(5):236-37.
[22] Burkhart HM, Cikrit DF. Arteriovenous fistula for hemodialysis. Semin Vasc Surg. 1997;10(3):162-65.
[23] Dember LM, Beck GJ, Allon M, Delmez JA, Dixon BS, Greenberg A. Effect of clopidogrel on early failure of arteriovenous fistula for hemodialysis: A randomized controlled trial. JAMA. 2008;299(18):2164-71.
[24] Lee T, Barker J, Allon M. Tunneled catheters in hemodialysis patients: Reasons and subsequent outcomes. Am J Kidney Dis. 2005;46(3):501-08.

[25] Stevenson KB, Hannah EL, Lowder CA. Epidemiology of hemodialysis vascular access infections from longitudinal infection surveillance data: Predicting the impact of NKF-DOQI clinical practice guidelines for vascular access. Am J Kidney Dis. 2002;39(3):549-55.

[26] Berardinelli L. The endless history of vascular access: A surgeon's perspective. J Vasc Access. 2006;7:103-11.

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