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A Study on Predictors of Outcome Following Radio-Cephalic Arteriovenous Fistula Creation in Patients with Chronic Renal Failure

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A B S T R A C T

Background: Radio-cephalic arteriovenous fistula (RC-AVF), particularly in the non-dominant limb, is widely regarded as the first choice for vascular access in hemodialysis. However, its success rate tends to decline in elderly patients and those with multiple comorbid conditions. Therefore, thorough preoperative assessment and vigilant postoperative observation are essential to address issues related to fistula maturation. This study was conducted to identify the various factors that influence the success of arteriovenous fistula creation.

Methods: This prospective study enrolled patients aged between 20 and 65 years diagnosed with chronic kidney disease, who had not undergone any prior RC-AVF procedures. The study period ranged from February 1, 2021, to January 31, 2022. Multiple variables—preoperative, intraoperative, and postoperative—were evaluated for their potential effect on fistula outcomes. All AVF surgeries were performed using an end-to-side anastomosis technique with 7-0 prolene suture applied via interrupted sutures.

Results: Among 250 enrolled patients, the highest fistula success rate (84%) was recorded in the 20–30 years age group. This was followed by 78% success rates in the 31–40 and 41–50 years groups. Male patients had a better success rate (61%) compared to female patients (39%). Additionally, a positive association was observed between successful fistula creation and the diameters of both the radial artery and cephalic vein.

Conclusion: Effective maturation of arteriovenous fistulas is significantly linked to ongoing postoperative evaluation. For optimal outcomes, clinical monitoring should begin intraoperatively and be sustained throughout the postoperative phase.

Keywords: Radio-cephalic arteriovenous fistula; Chronic kidney disease; Vascular access; Postoperative monitoring; Anastomosis.

INTRODUCTION

The effective functioning of an arteriovenous fistula (AVF) is essential for successful hemodialysis and forms a core component of long-term dialysis management [1]. A mature and patent AVF ensures sufficient blood flow and volume necessary for efficient dialysis sessions.

Globally, hemodialysis serves as a life-sustaining therapy for more than two million individuals each year [2]. Among the available vascular access options, AVF creation by vascular surgeons is considered the gold standard for permanent access [3]. Compared to synthetic grafts or central venous catheters, AVFs are associated with lower infection rates, extended patency, and reduced healthcare expenditure [4].

The procedure for AVF creation involves the surgical connection of an artery and a vein, typically starting with distal options like the wrist-level Brescia-Cimino fistula, followed by mid-forearm and brachiocephalic options in the proximal forearm if necessary [5]. The radio-cephalic fistula at the wrist remains the most frequently performed due to its simplicity and favorable anatomical location [5].

Despite its clinical advantages, the success of AVF creation is influenced by numerous factors, including the patient's age, associated comorbidities, and the caliber of the radial artery and cephalic vein [6]. Comprehensive clinical assessment prior to surgery and meticulous postoperative monitoring are essential to improve maturation and long-term

fistula functionality [6].

In summary, establishing a reliable AVF is a vital element in the management of hemodialysis patients. Careful patient evaluation, precise surgical execution, and diligent follow-up are critical to achieving favorable outcomes.

Arteriovenous Fistula Maturation

Physiology

The maturation process involves the remodeling of an AVF, making it suitable for cannulation and allowing adequate blood flow for hemodialysis. During AVF creation, a high flow artery is connected to a low flow vein, which leads to an elevation of blood flow and a rapid increase in wall shear stress (WSS). Studies have shown that the WSS of the vein increases rapidly from 1-6 dyn/cm^2 to 10-70 dyn/cm^2 [6]. From a biological perspective, maturation is related to the response of endothelial cells to changes in WSS [7,8]. There are two approaches to rebuild the venous wall:

a) Increased neointimal cell deposition and inward remodeling.
b) Eccentric medial hypertrophy caused by flow-mediated dilatation, which results in outward remodeling due to increasing circumferential tension [9]. The anastomotic segment is the location of AVF stenosis that occurs most frequently after formation.

Previous intravenous puncture sites may prevent outward remodeling and serve as stenosis sites [10]. AVF maturation is influenced by a number of variables, both adjustable and non-modifiable. Age, comorbidities, blood pressure, and other patient-specific characteristics are among the non-modifiable factors. Modifiable factors are related to the state of the vasculature. The arterial and venous network topology and geometry, the length and diameter of the vein segments, the elasticity and conformance of the vessel walls, pre- and postoperative radial artery disease, and lesion factors are among the vascular variables (stenosis number, location, and severity) [11]. There are several risk factors that influence the outcome of the AVF [12]. Age and diabetes have been shown to interfere with AVF maturation and increase the risk of AVF failure significantly [13,14]. Women mostly have smaller vessels than men, which results in poorer maturation and less long-term patency. Another non-modifiable factor that influences AVF maturation is the size of the artery and vein. Tobacco smoking is a well-known risk factor for vascular disease and arteriosclerosis [15].

MATERIALS AND METHODS

This prospective study included patients aged 20-65 years with chronic renal disease or incident end stage renal disease and no prior arteriovenous vascular access intervention. Patients were recruited from the plastic surgery OPD or admitted to the Department of Nephrology in a tertiary care hospital from February 1st, 2021 to January 31st, 2022. A total of 250 patients were included and categorized based on age, sex, comorbidities (such as diabetes, hypertension, peripheral vascular disease, systemic disease), history of smoking or tobacco use, obesity (BMI), drug history, and vessel wall characteristics (such as caliber of vessel, pulse volume, and vessel wall characteristics). To achieve a systemic analysis, intraoperative findings were evaluated, including branching pattern and vessel diameter of both radial artery and cephalic vein. Patients were also evaluated for postoperative findings, including any drug intake after surgery (such as heparin during dialysis or any antiplatelet drug intake), and were advised for physiotherapy and limb elevation after the surgical procedure was performed. Postoperative complications such as infection, hematoma formation, thrombosis, aneurysm, or failure of AVF were studied and analyzed. Routine outpatient visits were planned for follow-up at 1 week, 2 weeks, 4 weeks, and 10 weeks postoperatively. The success of AV fistula was considered after a 4-week postoperative period. Quantitative data were summarized and depicted on graphs and charts using descriptive statistics. Informed consent from the patient or their attendant was obtained, and a thorough physical examination of the patient was performed. Patients under the age of 20 years or over the age of 65 years were excluded from the study.

RESULTS

A total of 250 patients underwent AV fistula creation over a period of one year in our study from 1st February 2021 to 31st January 2022. The highest successful AVF creation was found in the age group of 20-30 years (84%) followed by the age group of 31-40 years and 41-50 years (78%). The lowest success rate was shown by the age group of 60-65 years (47%) with an overall success rate of 64% in all age groups (Figure 1). The percentage of successful AVF creation was found to be higher in males (61%) than in females (39%). Out of a total of 187 male patients, 116 were successful and 71 failed, while out of a total of 63 female patients, 25 were successful and 38 failed (Figure 2).

In our study, we analyzed the adverse effect of high BMI on the success of AVF creation. Out of 172 patients having BMI <30 kg/m^2, 118 patients had successful AVF creation (68% success), and out of 78 patients with BMI >30, only 25 of them had success (32% success) (Table 1). The highest number of AV fistula failures was seen in patients who had peripheral vascular disease (75%). This was followed by patients who had hypertension alone (45%) (Table 2).

This study revealed a higher failure rate of AV fistula creation in both male and female smokers. Out of 68 male smokers and 35 female smokers, only 15 and 7 patients had successful AVF creation, respectively (22% and 14% success

in males and females, respectively) (Figure 3). Smoking leads to atherosclerosis of arteries, which could be the main factor for AVF failure.

Additionally, this study found a close association between tobacco consumption and AV fistula failure. The success of AV fistula decreased in patients who were consuming tobacco or betel nut, both in males and females. Out of 150 male patients consuming tobacco, 86 of them had successful AVF creation (57% success), and only 5 female patients out of 28 who were consuming tobacco had successful AVF creation (18% success) (Figure 4).

Patients consuming drugs such as antiplatelets, anticoagulants, and statins showed a good response to AV fistula maturation in this study. Out of 64 patients taking antiplatelet drugs, 38 patients had successful AVF creation (59% success), and out of 15 patients who were taking anticoagulants, 11 of them had success (73% success). Ten patients who were on statins, six patients had successful AVF creation (60% success). We firmly believe that these drugs may alter the factors that might otherwise hamper AVF maturation. [Figure 5]

Branching pattern and vessel diameter were the intraoperative findings in this study. On careful evaluation and observation, it was found that the high success rate of AV fistula in patients having a single vein pattern rather than having multiple branches. The failure rate increases if multiple branching patterns are present. Out of 180 patients having a single vein pattern, 148 of them had successful AVF creation (82%), and out of 70 patients who were having a branching pattern, only 20 had successful AVF creation (29%). [Figure 6] The success rate of AVF also had an incremental relation with the diameter of the radial artery and cephalic vein. [Figure 7] shows a higher success rate of AV fistula creation in patients who had vein diameter more than 2mm. Out of 87 patients with vein diameter 1-2mm had 35% success rate while patients with vein diameter
>2mm had an 80% success rate.

Similarly, patients with radial artery caliber >2mm as compared to 1-2mm caliber, results showed patients with radial artery diameter >2mm had a 60% success rate, while those who had <2mm diameter were having a 40% success rate.

Chronic renal failure patients usually have higher blood pressure, and in this study, it showed that patients having higher preoperative blood pressure had a slightly better success rate. Patients those having blood pressure >140/80mmHg had a 62% success rate. [Table 3]

On counting the complications seen during this study, they were infection, hematoma, thrombosis, aneurysm, and failure. Maximum complication is of failure in total 82 patients, followed by infection in 64 patients (26%). Hematoma and thrombosis were noted in 20 (8%) and 56 (22%) patients, respectively. [Table 4]

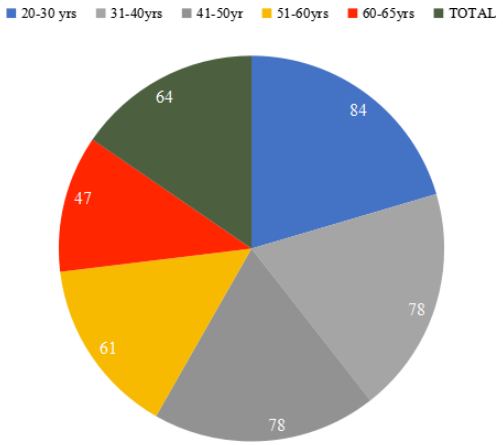

Figure 1. Showing percentage of successful Av fistulas according toage groups

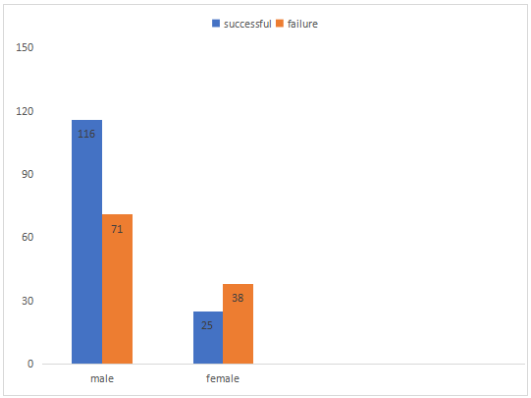

Figure 2. Bar graph showing successful and failure cases in men and female patients

Table 1. Obesity

	BMI<30kg/m^2	BMI>30kg/m^2
No.of patients	172	78
Successful	118	25
Failure	54	53
%Age success	68	32

Table 2. Co morbidities

Comorbidity	No. of patients	Success(percentage)	Failure(percentage)
Hypertension only	56	31 (55%)	25 (45%)
Diabetes mellitus only	64	52 (81%)	12 (19%)
Peripheral vascular disease(PVD) only	16	4 (25%)	12 (75%)
HTN+DM combined	136	92 (68%)	44 (32%)

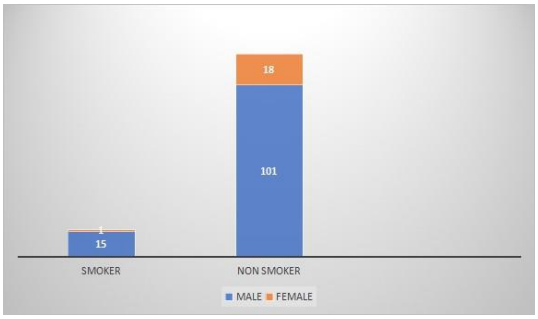

Figure 3. Shows successful cases of AVF in male and females having history of smoking

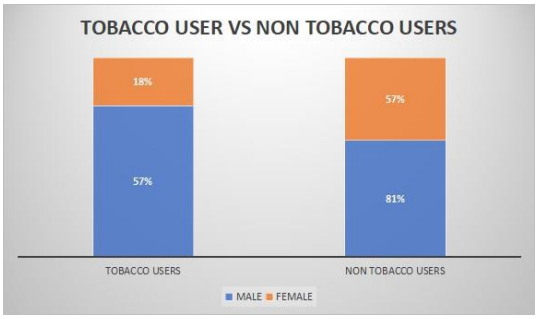

Figure 4. Shows percentage differences of av fistula success between male and female tobacco users versus non tabacco users

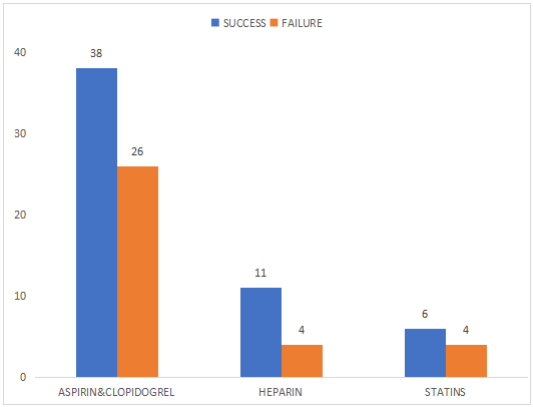

Figure 5. Shows number of successful av fistula creation in patients taking different drugs

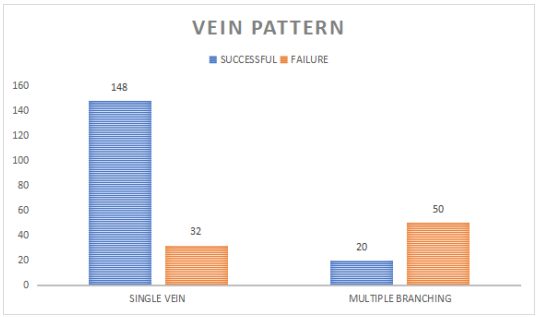

Figure 6. Showing higher rate of av fistula success in patients to have single cephalic vein pattern as compared to multiple branching pattern

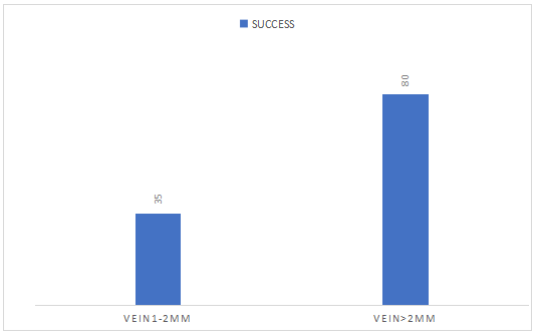

Figure 7. Showing higher success rate in patients having vein diameter >2mm

Table 3. Affect of preoperative blood pressure

Systolic BP	Diastolic BP	Patients	Percentage success
<140mm hg	<80mm hg	170	55%
>140mm hg	>80mm hg	80	62%

Table 4. Complications leading to failure

Complications	No. of patients
Infection	64
Hematoma	20
Thrombosis	56
Others(aneurysm)	0
No outcome	90

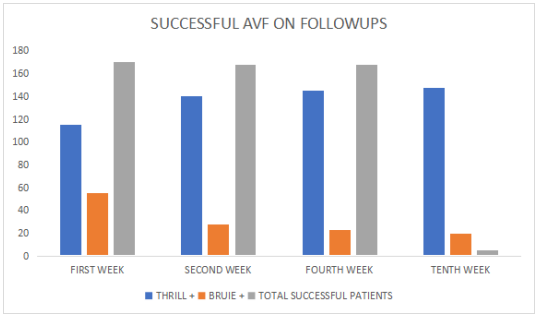

Figure 8. Explains the number of patients came for follow-up at first, second, fourth and tenth weeks

DISCUSSION

Long-term hemodialysis of patients with chronic renal failure depends on maintaining a patent and functional vascular access. Our study shows that the mean age of the patients in the elderly age group (51-65 years) and the success rate of AV fistula decreases with increasing age. The study conducted by Smith GE et al. shows that radiocephalic AVF had an increased failure rate and decreased patency in elderly patients ranging from 50-70 years, specific to wrist AVFs [16]. Another finding in our study is a higher success rate in males (61%) compared to females (39%). This study is in concordance with the study of Astor BC et al., where the results show poor maturation of fistulas in females because of thinner vessels than males [17].

While studying the comorbid factors in our study, we found that diabetes does not really affect the patency of AVFs as

52 patients out of 64 diabetic patients had successful AVF patency. Our study is in concordance with the results of Sedlackk et al., who reported no significant difference between diabetic and non-diabetic patients in the outcome of AVFs [18]. It was observed in our study that 31 patients out of 56 patients who had hypertension, AVF patency was successful. This observation was parallel to the study of Siddiqui et al., where there was no significant effect of hypertension on AV fistula outcome [19]. It was observed that out of 250 patients with chronic renal failure in our study, 136 of them were having hypertension and diabetes both, which is compared to the study done by Aljuid et al., where more than 40% of patients were suffering from hypertension and diabetes [20].

The effect of smoking was very detrimental to the results we found in this study, showing only 22% and 14% AVF success in males and females, respectively. This was supported by the results of Wetzig et al., who reported a significantly higher incidence of AV fistula failure in their study [21]. However, our study showed an ill effect of tobacco consumption on fistula outcome as the success rate fell from 81% to 57% in males, and only 18% success showed in females who had tobacco consumption. Obesity and BMI > 30 kg per square meter (kg/m^2) showed a higher failure rate compared to low BMI < 30 kg per square meter (kg/m^2) [Table 1]. This finding was similar to the results of M.R. Chan et al., whose results showed a high failure rate in patients with high BMI, i.e., >30 kg/m^2 [22]. Antiplatelet drugs like aspirin and clopidogrel did not show any favorable effect in this study, which is in contrast to the results of Paraskevas et al. [23]. Our study was supported by Dember LM et al., where they gave the conclusion that clopidogrel did not increase the proportion of fistula [24].

In this study, we found that heparin had good intraoperative results as 11 out of 15 patients had successful fistula creation. This result was similar to the results of Ravari H et al. who also showed positive intraoperative results with heparin [25]. A newer observation noted in this study came from the branching pattern of the cephalic vein. The single pattern vein showed better results than the multiple branching patterned vein. This could be due to the distribution of blood flow distal to the anastomosis.

The study showed better results in patients with a vein diameter >2mm. These results were similar to the study of C. Glass et al. which showed a 71% success rate in veins with a diameter >2mm as compared to a 29% success rate in veins with a diameter <2mm. Similarly, a radial artery diameter >2mm showed good results, which correlated with the study of C. Glass et al. [26]. Preoperative blood pressure >140/80 mmHg showed good results [see Table 3]. These results were similar to the studies of Culp et al. [27].

Our observations during the follow-up period of 10 weeks showed a success rate of 168 out of 250 patients who underwent fistula creation. Maturation in the study was considered the time period beyond 4 weeks. During the follow-up period, we encountered some complications such as wound infection, thrombosis, hematoma formation, and failure [see Table 4]. This study was conducted to avoid such factors that may lead to the failure of fistula maturation. Additional studies could be conducted to examine the effects of certain drugs (hypoxia-inducing drugs, statins, blood thinners, etc.) on the outcome. Various experimental studies can also be conducted to promote neointimal cell hyperplasia by hypoxia-inducible factors. In addition, interventional radiological studies could be conducted to enhance the maturation of radiocephalic AV fistulas.

CONCLUSION

Ensuring reliable vascular access is fundamental to the success of hemodialysis therapy. The maturation and long-term functionality of an arteriovenous fistula (AVF), particularly a radiocephalic fistula, are highly dependent on consistent monitoring throughout the perioperative period. Early consideration of RC-AVF, along with meticulous planning, should be initiated during the surgical procedure and sustained in the postoperative phase. Although pharmacological strategies to enhance maturation have shown limited benefit, there is a pressing need to explore and develop advanced monitoring tools and techniques. Preventing factors that contribute to AVF failure, coupled with prompt identification and management of complications, is vital for improving fistula outcomes and ensuring continuity of dialysis care.

Limitations

The only limitation of our study was the lack of follow-up for some patients beyond 10 weeks postoperatively. Some patients were unable to visit our hospital from remote areas of northeast India, and other patients developed successful AV fistulas.

Ethical approval and consent to participate: This study was approved by the Ethics Committee of Gauhati Medical College and Srimanta Sankaradeva University of Health Sciences, Guwahati. Written informed consent was obtained from the patients and guardians of the patients.

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Author Contributions: All authors contributed equally to the writing of this paper. All authors read and approved the final manuscript.

Conflicts of Interest: Nil.

REFERENCES

1. Siddiqui, M. A., Ashraff, S., & Carline, T. (2017). Maturation of arteriovenous fistula: analysis of key factors. *Kidney Research and Clinical Practice, 36*(4), 318-328.
2. Couser, W. G., Remuzzi, G., Mendis, S., & Tonelli, M. (2011). The contribution of chronic kidney disease to the global burden of major noncommunicable diseases. *Kidney International, 80*(12), 1258-1270.
3. https://www.niddk.nih.gov/health-information/kidney-disease/kidney-failure/hemodialysis/vascular-access.
4. Sidawy, A. N., Spergel, L. M., Besarab, A., Allon, M., Jennings, W. C., Padberg Jr, F. T., ... & Ascher, E. (2008). The Society for Vascular Surgery: clinical practice guidelines for the surgical placement and maintenance of arteriovenous hemodialysis access. *Journal of Vascular Surgery, 48*(5), S2-S25.
5. Idrees, M., Suthananthan, A., Pathmarajah, T., & Sieunarine, K. (2020). Snuffbox fistula-a first-line approach to haemodialysis: a review. *The Journal of Vascular Access, 21*(5), 554-563.
6. Fitts, M. K., Pike, D. B., Anderson, K., & Shiu, Y. T. (2014). Hemodynamic shear stress and endothelial dysfunction in hemodialysis access. *The Open Urology & Nephrology Journal, 7*(Suppl 1 M5), 33-44.
7. Remuzzi, A., & Bozzetto, M. (2017). Biological and physical factors involved in the maturation of arteriovenous fistula for hemodialysis. *Cardiovascular Engineering and Technology, 8*(3), 273-279.
8. Remuzzi, A., Bozzetto, M., & Brambilla, P. (2017). Is shear stress the key factor for AVF maturation?. *The Journal of Vascular Access, 18*(1_suppl), S10-S14.
9. Nath, K. A., & Katusic, Z. S. (2016). Predicting the functionality and form of a dialysis fistula. *Journal of the American Society of Nephrology, 27*(12), 3508-3510.
10. Zhao, J., Jourd'heuil, F. L., Xue, M., Conti, D., Lopez-Soler, R. I., Ginnan, R., ... & Long, X. (2017). Dual function for mature vascular smooth muscle cells during arteriovenous fistula remodeling. *Journal of the American Heart Association, 6*(4), e004891.
11. Hammes, M. (2015). Hemodynamic and biologic determinates of arteriovenous fistula outcomes in renal failure patients. *BioMed Research International,* 2015.
12. Gameiro, J., & Ibeas, J. (2020). Factors affecting arteriovenous fistula dysfunction: a narrative review. *The Journal of Vascular Access, 21*(2), 134-147.
13. Conte, M. S., Nugent, H. M., Gaccione, P., Roy-Chaudhury, P., & Lawson, J. H. (2011). Influence of diabetes and perivascular allogeneic endothelial cell implants on arteriovenous fistula remodeling. *Journal of Vascular Surgery, 54*(5), 1383-1389.
14. Lazarides, M. K., Georgiadis, G. S., Antoniou, G. A., & Staramos, D. N. (2007). A meta-analysis of dialysis access outcome in elderly patients. *Journal of Vascular Surgery, 45*(2), 420-426.
15. Astor, B. C., Coresh, J., Powe, N. R., Eustace, J. A., & Klag, M. J. (2000). Relation between gender and vascular access complications in hemodialysis patients. *American Journal of Kidney Diseases, 36*(6), 1126-1134.
16. Smith, G. E., Gohil, R., & Chetter, I. C. (2012). Factors affecting the patency of arteriovenous fistulas for dialysis access. *Journal of Vascular Surgery, 55*(3), 849-855.
17. Astor, B. C., Coresh, J., Powe, N. R., Eustace, J. A., & Klag, M. J. (2000). Relation between gender and vascular access complications in hemodialysis patients. *American Journal of Kidney Diseases, 36*(6), 1126-1134.
18. Sedlacek, M., Teodorescu, V., Falk, A., Vassalotti, J. A., & Uribarri, J. (2001). Hemodialysis access placement with preoperative noninvasive vascular mapping: comparison between patients with and without diabetes. *American Journal of Kidney Diseases, 38*(3), 560-564.
19. SSiddiqui, M. A., Ashraff, S., & Carline, T. (2017). Maturation of arteriovenous fistula: analysis of key factors. *Kidney Research and Clinical Practice, 36*(4), 318-328.
20. Aljuaid, M. M., Alzahrani, N. N., Alshehri, A. A., Alkhaldi, L. H., Alosaimi, F. S., Aljuaid, N. W., ... & Atalla, A. A. (2020). Complications of arteriovenous fistula in dialysis patients: Incidence and risk factors in Taif city, KSA. *Journal of Family Medicine and Primary Care, 9*(1), 407-411.
21. Wetzig, G. A., Gough, I. R., & Furnival, C. M. (1985). One hundred cases of arteriovenous fistula for haemodialysis access: the effect of cigarette smoking on patency. *Australian and New Zealand Journal of Surgery, 55*(6), 551-554.
22. Chan, M. R., Young, H. N., Becker, Y. T., & Yevzlin, A. S. (2008, May). Obesity as a predictor of vascular access outcomes: analysis of the USRDS DMMS Wave II study. In *Seminars in Dialysis* (Vol. 21, No. 3, pp. 274-279). Oxford, UK: Blackwell Publishing Ltd.
23. Paraskevas, K. I., Mikhailidis, D. P., Roussas, N., & Giannoukas, A. D. (2012). Effect of antiplatelet agents, statins, and other drugs on vascular access patency rates. *Angiology, 63*(1), 5-8.
24. Dember, L. M., Beck, G. J., Allon, M., Delmez, J. A., Dixon, B. S., Greenberg, A., ... & Dialysis Access Consortium Study Group. (2008). Effect of clopidogrel on early failure of arteriovenous fistulas for hemodialysis: a randomized controlled trial. *Jama, 299*(18), 2164-2171.

25. Ravari, H., Kazemzade, G., Sarookhani, A., & Khashayar, P. (2008). Effect of heparin on the patency of arteriovenous fistula. *Acta Medica Iranica*, 379-382.
26. Glass, C., Johansson, M., DiGragio, W., & Illig, K. A. (2009). A meta-analysis of preoperative duplex ultrasound vessel diameters for successful radiocephalic fistula placement. *Journal for Vascular Ultrasound, 33*(2), 65-68.
27. Culp, K., Flanigan, M., Taylor, L., & Rothstein, M. (1995). Vascular access thrombosis in new hemodialysis patients. *American Journal of Kidney Diseases, 26*(2), 341-346.