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INTRODUCTION

Arteriovenous (AV) fistulas are the preferred vascular access for patients requiring long-term hemodialysis due to their lower complication rates and longer patency compared to other vascular access types (1). However, early failure and maturation issues remain significant challenges in AV fistula creation and management (2,3).

Oblique versus Straight skin incision: The impact of incision type on postoperative outcomes in distal radiocephalic arteriovenous fistula creation

Abstract

Aim: The type of skin incision utilized in arteriovenous (AV) fistula creation may significantly influence the patency, maturation, and overall outcomes of the fistulas. An oblique skin incision may offer distinct advantages in preventing early AV fistula failure by reducing skin tension and minimizing pressure on the newly formed anastomosis. This study aims to compare the postoperative early period outcomes of oblique versus straight skin incision techniques, with a focus on their impact on AV fistula success.

Material and Methods: 2020 to 2023, all patients with created AV fistula via distal antebachial vessels with oblique and straight skin incisions were enrolled. Retrospectively, the patients' demographics, comorbidities were collated from the hospital data. All patients were operated with local anesthesia for radiocephalic AV fistula creation. The characteristics of the vessels were determined through preoperative Doppler ultrasonography mapping. Evaluations were conducted on primary patency, early maturation, and the incidence of early thrombosis.

Results: In Total, 182 patients were operated for AV fistula creation. The mean age was 57 ± 17 years and there was a male predominance with %68. We performed 74 patients AVF creation via straight skin incision and 108 via oblique skin incision. Despite there being no differences in comorbidities and demographic characteristics between the two groups, the group with a straight skin incision exhibited a higher incidence of early thrombosis ($p=0.03$), a lower maturation rate ($p=0.03$), and reduced primary patency ($p=0.01$).

Conclusion: Oblique skin incision could be a feasible alternative to conventional straight incision with a higher early AVF patency and lower thrombosis rates. Reducing the pressure on and keeping the incision away from the new anastomosis may be crucial for achieving better outcomes.

Keywords: Arteriovenous fistula, incision type, maturation

The surgical technique used in AV fistula creation plays a crucial role in determining its success (4). While much attention has been given to vessel selection, anastomosis technique, and postoperative care, the impact of skin incision type on fistula outcomes has been less extensively studied (4).

Traditionally, a straight skin incision has been the standard approach for AV fistula creation. However, this technique may

lead to increased tension on the newly created anastomosis, potentially compromising blood flow and increasing the risk of early failure (5). Oblique skin incisions have been proposed as an alternative that may reduce pressure on the anastomosis and improve outcomes.

This study seeks to compare the postoperative outcomes of oblique skin incisions versus conventional straight skin incisions in radiocephalic arteriovenous fistula (RCAVF) creation, focusing on early patency rates, maturation, and complications. The use of oblique incisions may result in enhanced early patency rates and a reduction in complications.

MATERIAL AND METHODS

This study adhered to the Declaration of Helsinki guidelines and received approval from the Institutional Review Board (E2-24-6159). It is a retrospective study involving 182 patients who had an RCAVF created using distal antebrachial vessels at our institution between 2020 and 2023. We included patients who were over 18 years old and undergoing their first RCAVF creation. We excluded patients who had previous vascular access in the same arm or had inadequate vessels based on preoperative mapping, specifically if the cephalic vein or radial artery was less than 2 mm in diameter. Patient demographics, comorbidities, and pertinent clinical information were obtained from hospital medical records.

The patients were categorized into two groups according to the type of skin incision employed: oblique or straight. The choice of incision type was primarily determined by the surgeon. Preoperatively, all patients underwent routine doppler ultrasound mapping, performed by the surgeon using the Clarius L7 linear probe (Clarius Mobile Health, Vancouver, BC, Canada), to ensure accurate vascular visualization.

We defined mature fistulas as those that meet specific anatomical and functional criteria at 6 weeks after creation. The diameter of the outflow vein should be at least 6 mm, and its depth should not exceed 0.5 to 0.6 cm. Additionally, the blood flow rate should reach or exceed 600 mL/min by this time. The fistula should also have an outflow length of 5 to 6 cm to facilitate successful two-needle dialysis (6).

Operative Technique

All procedures were performed under local anesthesia for RCAVF creation. In the oblique incision group, the surgical approach involves making the skin incision such that it traverses distally over the cephalic vein and proximally over the radial artery. All RCAVFs were constructed using an end-to-side anastomosis technique. The anastomosis was performed with a continuous suture of 7/0 monofilament polypropylene, employing the parachute technique from heel to base, secured with a single knot. The arteriotomy was precisely limited to a length of 4-6 mm. The angle of anastomosis was meticulously maintained between 30° and 60° to optimize hemodynamic flow. All surgical incisions were closed using 3/0 polypropylene mattress sutures to ensure appropriate wound healing (Figure 1).

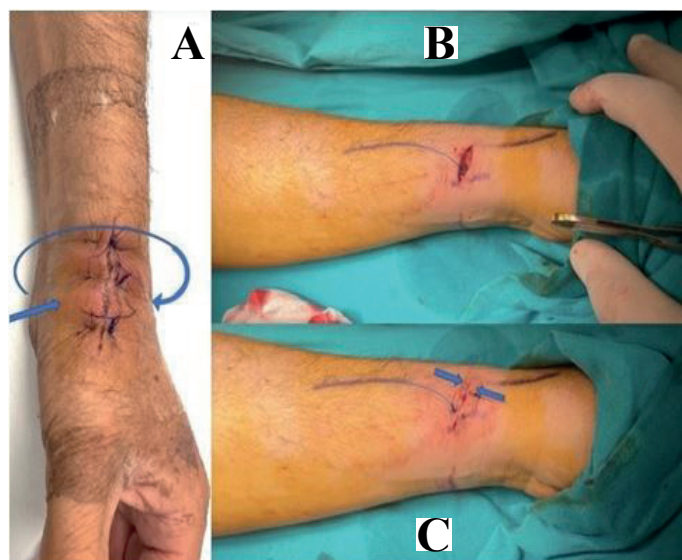


Figure 1. A. The image of Postoperative second control of a patient with straight incision: demonstrates the skin tension; B,C. intraoperative view of oblique incision

Postoperative care and follow-up protocols were standardized for all patients. The initial postoperative period, extending from immediately after surgery until hospital discharge, involved close monitoring for early complications such as bleeding or thrombosis.

Approximately ten days postoperatively, patients returned for suture removal and a clinical examination, which included palpation to detect a thrill, a crucial indicator of fistula patency.

The third control conducted between the fourth and sixth weeks postoperatively, focused on AV fistula maturation. This was assessed through inspection, palpation for thrill, and doppler ultrasound to measure flow volume and evaluate functional maturity.

The primary outcomes of this study were the primary patency and fistula maturation rates at 6 weeks post-operation. Secondary outcomes included the incidence of early thrombosis within the first 6 weeks and the occurrence of postoperative complications such as hematoma.

Statistical Analysis

Statistical analysis was conducted using SPSS for Windows version 24.0 software (IBM Corp. Armonk, New York, USA). Continuous variables were expressed as mean±SD, and categorical variables as percentages. Kolmogorow-Smirnov test was used to determine the distribution of the numerical variables. Independent samples t-test was used to compare continuous variables. Chi-square or Fisher's exact test (if expected cell frequencies <5) compared categorical variables. Kaplan-Meier analysis with a log-rank test compared primary patency. For all analyses, probability values were considered significant if less than 0.05.

RESULTS

A total of 182 patients underwent AV fistula creation during the study period. The mean age of patients was 57 ± 17 years and there was a male predominance with 68%. Both groups had a

similar proportion of male participants. 74 patients underwent AV fistula creation via straight skin incision, while 108 patients had oblique skin incisions. There were no significant differences in demographics or comorbidities between the two groups (Table 1).

Table 1. Clinical features of the study population

Variables	Oblique incision (n=108)	Straight incision (n=74)	P value
Age (years)	56+15	59+16	0.14
Male, n (%)	74 (68)	50 (68)	0.89
Diabetes mellitus, n (%)	52 (48)	37 (50)	0.80
Hypertension, n (%)	71 (66)	46 (62)	0.80
Cardiovascular disease, n (%)	31 (29)	22 (30)	0.88

Patients who underwent AV fistula creation with oblique skin incisions demonstrated significantly lower rates of early thrombosis compared to those with straight incisions ($p=0.03$). Additionally, the oblique incision group had a higher incidence

of maturation rate ($p=0.03$). Also the primary patency rate at 6 weeks was significantly higher in the oblique incision group with a statistically significant difference ($P=0.01$) (Table 2).

Table 2. Postoperative outcomes

Variables	Oblique incision (n=108)	Straight incision (n=74)	P value
Primary patency	95 (88)	54 (73)	0.01
Maturation	88 (82)	50 (68)	0.03
Early thrombosis	13 (12)	18 (24)	0.03
Hematoma	4 (4)	4 (5)	0.58
Cardiovascular disease, n (%)	31 (29)	22 (30)	0.88

Kaplan-Meier curves were used to calculate the probabilities of primary patency for oblique and straight incisions (Figure 2).

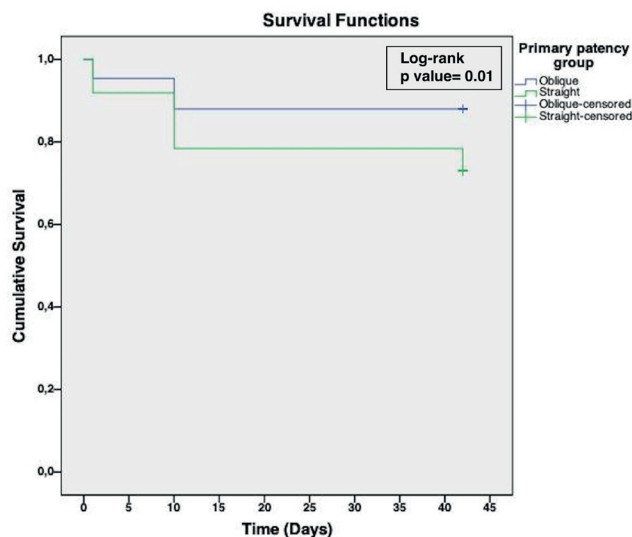


Figure 2. Kaplan–Meier analysis; the 6 week cumulative patency rates; statistical differences were analyzed using Kaplan–Meier survival curves and the log-rank test

DISCUSSION

The autogenous AV fistula is widely recognized as the gold standard for vascular access in patients with end-stage renal disease (ESRD) necessitating chronic hemodialysis (7). This preeminence is attributed to its significantly lower incidence of complications when compared to alternative access modalities, such as central venous catheters (CVCs) and prosthetic arteriovenous grafts (7). The surgical creation of AV fistulas represents a critical and indispensable component in the comprehensive management and long-term care of ESRD patients undergoing hemodialysis (8). This procedure not only facilitates effective dialysis but also contributes substantially to improved patient outcomes, reduced morbidity, and enhanced quality of life (7,8). The superiority of AV fistulas in terms of patency rates, infection resistance, and overall patient satisfaction underscores their pivotal role in modern renal replacement therapy protocols (7,8).

The RCAVF, emerges as the preeminent vascular access modality for patients with chronic renal insufficiency, owing to its superior long-term patency rates in comparison to alternative access methods. This approach not only confers enhanced

longevity of vascular access but also contributes significantly to improved quality of life and patient comfort, thereby positioning it as the preferred choice among nephrologists and vascular surgeons for hemodialysis access creation which has a longer patency rate compared to other vascular access methods (9). In this context, we examined the early patency and maturation rates of RCAVFs performed with two different skin incisions, as well as their impact on improved patient outcomes in our study. The study cohort comprised 182 patients who underwent distal RCAVF procedures, with 74 receiving a straight incision and 108 receiving an oblique incision. Our observations indicate that patients who underwent surgery with an oblique incision demonstrated significantly higher early maturation rates ($p=0.03$), lower rates of early thrombosis ($p=0.03$), and superior patency rates ($p=0.01$) compared to those with a straight incision.

Many studies have been conducted to determine the factors contributing to RCAVF failure (10,11). One of the factors influencing the success of these surgeries is the characteristics of the procedure itself. Elements such as target vessel selection, vessel quality, the surgical technique employed, and the management of postoperative complications play a crucial role (12). Additionally, the choice of skin incision for the surgery can also be considered among these factors (5). In our study patients who underwent RCAVF surgery with two different skin incisions demonstrates that the use of oblique skin incisions in AV fistula creation is associated with improved early outcomes compared to traditional straight incisions. The group with a straight incision had a higher incidence of early thrombosis and maturation failure during follow-ups.

Factors contributing to early thrombosis and maturation failure in AV fistulas can be varied (13-15). They are generally related to both surgical technique and the individual characteristics of the patient (10,11).

Surgical technique errors, such as improper anastomotic angle or the presence of stenosis, can obstruct blood flow and precipitate thrombosis (10,12). Additionally, excessive manipulation or inadvertent damage to the vessels during surgery may result in endothelial injury, further contributing to the development of thrombosis (15).

Postoperative inflammation and edema can also exert pressure on the vessels, thereby restricting blood flow and increasing the likelihood of thrombosis (15,16). Furthermore, underlying vascular conditions, such as atherosclerosis or diabetes, along with a hypercoagulable state, can significantly elevate the risk of thrombotic events. Early thrombosis was also found to be associated with female gender, forearm AV fistula, smaller arterial size, draining vein diameter of 2 to 3 mm, and protamine use (11). Conversely, Korn et al. reported that factors such as gender, diabetes, undergoing dialysis at the time of surgery, fistula configuration, and systemic heparin use were not significantly associated with early thrombosis (13).

In a recent study, venous stenosis was identified as the most prevalent cause of early thrombosis, accounting for 64.4% of cases, followed by inadequate arterial inflow, which was reported in 28.9% of cases (17). In our study the early thrombosis can be attributed to increased subcutaneous tissue edema, which could have exerted pressure on the arteriovenous fistula, leading to compromised flow. In the physical examinations (as seen in Figure 1), patients in the straight incision group exhibited pronounced subcutaneous tissue swelling and increased tissue tension, which may be a result of the body's inflammatory response to the incision. An additional factor influencing the maturation of RCAVFs is the use of an oblique incision. The oblique incision technique in arteriovenous fistula creation offers several anatomical and physiological advantages. Primarily, it facilitates the strategic positioning of the cephalic vein, the critical outflow component, beneath the medial flap rather than directly under the incision site. This positioning potentially mitigates external pressure on the vein, which may contribute to improved patency rates. Furthermore, the oblique approach provides superior exposure of both the artery and vein, enabling more extensive mobilization without necessitating undue vessel approximation or tension at the anastomosis site (1). This enhanced exposure and mobilization capability inherently reduces the risk of shear stress and cephalic vein torsion, a complication frequently observed with the extensive mobilization required in traditional straight incisions (3,15). The cumulative effect of these anatomical benefits may translate to improved early outcomes and reduced complication rates in arteriovenous fistula creation (5,7).

The maturation process showed a significantly better outcome in the oblique incision group. In particular, thrill palpation and doppler flow measurements indicated superior maturation in the oblique group. This finding suggests that the oblique incision may promote more favorable hemodynamics, potentially by minimizing postoperative tissue edema and providing a better anatomical alignment of the vessel. The enhanced outcomes associated with oblique incisions can be attributed to several factors. Firstly, oblique incisions may alleviate tension on the newly created anastomosis, thereby potentially enhancing blood flow and reducing the risk of early thrombosis. Additionally, by situating the incision away from the anastomosis site, oblique incisions may decrease the likelihood of direct trauma or compression to the fistula during the critical early maturation period (7). Reducing the pressure on and keeping the incision away from the new anastomosis may be crucial for achieving better outcomes.

In our study, the oblique incision group showed significantly higher early maturation rates ($p=0.03$) and lower early thrombosis rates ($p=0.03$) compared to the straight incision group. These findings suggest that the oblique incision technique may offer anatomical and physiological advantages, such as reduced external pressure on the cephalic vein and better

exposure and mobilization of the artery and vein, which may contribute to increased patency and reduced complication rates in the early postoperative period. More importantly, the absence of significant differences in demographic variables between the patient groups, the consistency of the surgical team, and the uniformity of the location of the fistula site strengthen the possibility that the significant results observed can be attributed to the type of skin incision used. These controlled factors suggest that the incision technique itself may play an important role in influencing the results and thus increase the validity of the relationship between the type of skin incision and surgical outcomes.

This study provides valuable insights into the impact of incision type on the early outcomes of RCAVF creation, significantly contributing to the existing literature on vascular access for hemodialysis. By comparing oblique and straight skin incisions, our research highlights the potential benefits of the oblique incision technique in enhancing early maturation rates and reducing the incidence of early thrombosis. There is a notable gap in the research regarding the application of oblique incisions. Our study addresses this gap and offers new evidence that may influence surgical practices and improve patient outcomes by providing insights into the outcomes associated with the use of oblique incisions in RCAVF creation.

Limitations of this study include its retrospective nature, which inherently restricts the ability to control for confounding variables and may affect the reliability of the findings. Additionally, there is potential for selection bias in the choice of incision type, as this may have been influenced by patient characteristics or surgeon preference rather than randomized allocation. The small sample size further limits the study's statistical power and generalizability, potentially affecting the robustness of the conclusions.

CONCLUSION

The oblique incision technique in RCAVF creation appears to offer significant advantages in terms of early maturation and reduced thrombosis rates.. Future prospective studies with larger sample sizes and randomized allocation are warranted to further validate these findings and explore the underlying mechanisms contributing to the improved outcomes associated with oblique incisions.

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Ethics Committee Approval: Ethic approval received from the Institutional Review Board (E2-24-6159).

Patient Informed Consent: Not necessary for this manuscript.

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