

HORIZONTAL VERSUS CONVENTIONAL STRAIGHT SKIN INCISION OF AUTOGENOUS RADIOCEPHALIC ARTERIOVENOUS FISTULA IN OUR INSTITUTE-A RETROSPECTIVE STUDY

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Abstract

Introduction: Surgeons who perform radio cephalic arterio venous fistulas give vertical incision which is the conventional method. The objective of this study is to compare horizontal surgical incision versus conventional straight skin incision in the creation of radiocephalic arteriovenous fistulas. The primary end-point is primary functional maturation and secondary end points are stenosis and thrombosis.

Methods: A Retrospective observational comparative study. All patients undergoing only radiocephalic arteriovenous fistula (RCAVFs) over a period of 6 months were included in the group. Variables on patient's demographics, comorbidities, anesthesia type, mean arterial blood pressure, thrill, laterality, cephalic vein and radial artery diameter were collected. The test of probability was assessed through Chi-Square, Kaplan-Meier survival estimator and Log-Rank analysis.

Results: Total of n=166 individuals with median age of 65 years and male predominance 83% during this period were subjected to RCAVF formation. Total of n=80 patients in straight skin incision were compared to n=76 individuals in horizontal group. Despite equal prevalence of demographics, comorbidities, anesthesia type, mean arterial blood pressure (MAP), thrill, laterality, cephalic vein and radial artery diameter ($p>0.05$) higher incidence of juxtaanastomotic stenosis was noted in the straight skin incision group ($p=0.029$) in comparative and survival analysis (Log-Rank, $p= 0.036$). The maturation of the entire cohort was 69% (Horizontal 76% vs straight group 62%) ($p>0.05$).

Conclusion: The outcome of this study demonstrates that horizontal surgical skin incision is associated with a lower incidence of stenosis and thrombosis in comparison to straight incision type in RCAV Formation.

Key Words: radiocephalic arteriovenous fistulas, Kaplan-Meier survival estimator, Log-Rank analysis

INTRODUCTION

Vertical skin is the standard incision used for Radiocephalic fistula creation. Failure of primary functional maturation is the main problem and ranges from 10% to 70% in different centres. Failure leads to depend temporary catheters for dialysis, need for prosthetic conduits. Overall increase in cost and utilization of health care resources. Impact of different variables on Primary functional maturation of radiocephalic arteriovenous fistula were done by various

studies and impact of surgical skin incision on primary FM of RCAF was done by only one study to date. This study assessed the impact of horizontal incision to that of conventional type in practice and was associated with poor outcomes.

In Straight incision, which is commonest technique worldwide, incision is given midway between the radial artery and cephalic vein. Since cephalic vein remains directly under the incision line, It has been suggested that tension as a consequence of wound approximation, local inflammatory changes (healing process) and extracellular matrix deposition might result in outflow stenosis and/or thrombosis. In addition, extensive mobilisation of the cephalic vein in conventional method could also result in proximal twisting of the vein on its pedicle.

Majority of stenotic sites are within the 2-3 cm of cephalic vein and from anastomosis site, so a different type of skin incision (Horizontal) might prove beneficial in reducing such adverse events in practice. Therefore, it was hypothesized (null hypothesis) that horizontal skin incision in comparison to the conventional (straight skin) method has no impact on the primary end point of functional maturation and secondary end point of stenosis and thrombosis of RCAF.

MATERIAL AND METHODS

It is a prospective observational comparative study. All patients undergoing only left radiocephalic arteriovenous fistula (RCAVFs) under Local anaesthesia in our institution, from 1st of December 2022 to 1st of June 2023 are included. Variables are incision type (horizontal versus straight incision) (Fig. 1) (Fig. 2) patient's demographics (age, gender), anatomical variance (cephalic vein, radial artery diameter), comorbidities (Diabetes mellitus (DM), Ischemic heart disease (IHD), congestive cardiac failure (CHF), hypertension (HTN), hypercholesteremia), perioperative variables, presence of intraoperative thrill and/or not) and mean arterial blood pressure (MAP). The primary end point of the study is set at primary functional maturation (FM). The secondary end points are stenosis and thrombosis.

The patients are subjected to two groups of Horizontal and straight incision depending on surgeon's preference of incisions horizontal versus straight. In our center, one surgeon performs horizontal and other, straight incision with equal amount of experience in renal access surgery. The allocation process started from the time of referral (nephrologists) and in preoperative consultation stage.

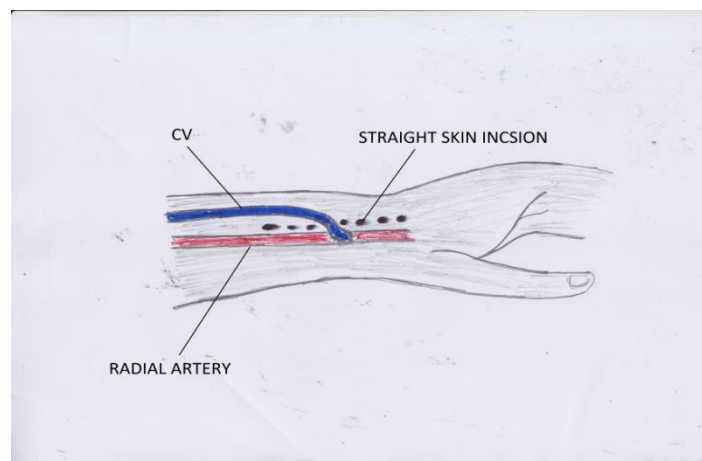


Fig.1. Conventional straight skin Incision, demonstrating the position of the incision to that of cephalic vein, radial artery and anastomosis on a left hand.

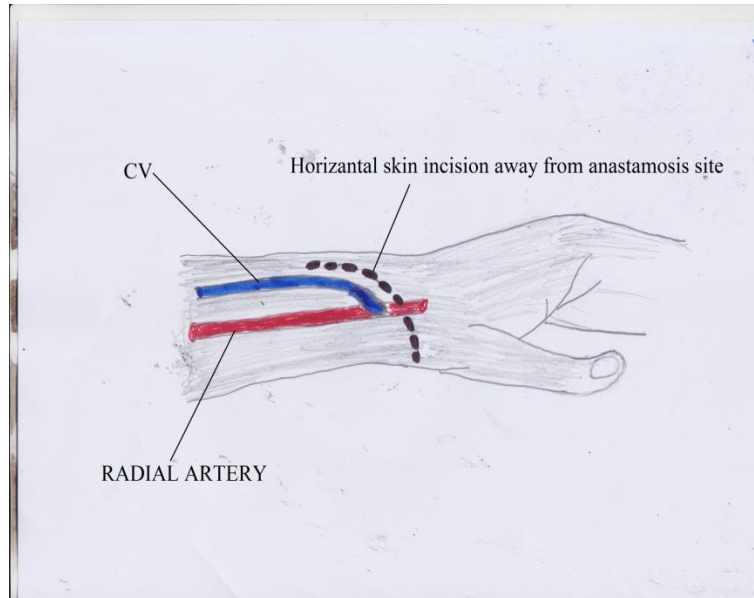


Fig.2. horizontal skin incision, demonstrating the position of the incision away from anastomosis site on a left hand.

Functional maturation is defined against the “Rule of 6’s” assessed clinically and with duplex ultrasonography at 6 weeks’ post RCAVF formation, with a depth of not more than 0.5-0.6 cm from skin and diameter (main body of fistula) of 6 mm with a flow rate of 600 ml/min and length of 5-6 cm for successful two-needle cannulation and dialysis.

Stenosis was defined as reduction in the diameter of the vessel by at least >50% and more resulting in reduction of access flow or in measured dialysis dose.

The cephalic vein was considered suitable if the “Tap test”(application of tourniquet proximally and percussion of the vein with fingers for vibration across the course of the vein) was positive and the vein was continuous to the median cubital fossa and/or cephalic vein of arm directly or in directly with a consistent diameter and/or more throughout. Cephalic vein was assessed in non-augmented (no tourniquet) state. The radial artery was used and assessed further with ultrasound only if “Allen’s test” was normal (positive) indicating adequate blood flow in ulnar artery and palmer arch. The radial artery was also assessed for hemodynamic studies (flow and stenosis) and not used for RCAVF if changes were noted.

Preoperative duplex of cephalic vein and radial artery, assessed the internal diameter of both vessels with linear transducer of 5-7 Mhz with arm position fully rested at 45-60 degrees [12]. Comorbidities were categorized and defined in accordance with definitions provided by world health organization (WHO). All fistulas were created by an end (cephalic vein)-to-side (radial artery) anastomosis using 3X magnifying lenses with 6/0 monofilament polypropylene continuous suture from heel to base with parachute technique and a single knot. All incisions were closed with 2/0 interrupted nylon suture .

The angle of anastomosis was set at no less than 30 degrees to 65 degrees. The arteriotomy length was limited to 4 mm. Intraoperative heparin 100IU/kg body weight administered before arteriotomy and post operatively antiplatelet therapy(ecosprin) was given for 1 month. The local anesthesia was 2% lignocaine with adrenaline on preoperative marked area. Follow-up was set on 1st, 2nd, 4th and 6th week of RCAVF creation.

Statistical analysis: All continuous variables are written and median obtained with their corresponding interquartile ranges (IQR) and categorical variables as percentages. The continuous data on cephalic vein and radial artery diameter were reorganized to form a categorical variable based on cut-offs obtained via the coordinates on a receiver operator curve (ROC). Diameter at best sensitivity and 1-specificity was taken to be the optimal cut-off diameter. The relative proportions of one group (straight incision) with their variable against independence of the second group (S-shaped) and the test of probability (p value) was conducted using two tailed Chi-square test on the end point of primary functional maturation (FM) (Table 1). Subgroup analysis was performed using Kaplan-Meier estimator to assess the impact of incision type (S-shaped vs. Straight) on the end point of stenosis and thrombosis respectively. The null hypothesis (p value) was assessed using Log-Rank test on each end point (Fig.3) (Fig. 4). Outcome was considered statistically significant if the p-value was 0.05. All statistical analyses were carried out using the Statistical Package for the Social Sciences (SPSS) version 20, IBM.

RESULTS

Total of n=166 individuals were subjected to RCAVF formation during this period (6 months). The median age of the entire cohort was 65 years (IQR, 20-89) with male predominance 83% (n=134/166). Majority of the operations were performed under local anesthesia 98% (n=164/166) and on the non-dominant hand (left-side) 83% (n =138/166). Primary functional maturation (FM) occurred in 69% (n = 114/166), stenosis was detected in 14% (n =22/166) and thrombosis in 15.3% (n = 26/166). The most common comorbidity was hypertension (n = 114/166) and the least common was ischemic heart disease 15.6% (n =26/166). The receiver operator curve for both vessel diameters at three decimal points for the best sensitivity and 1-specificity was 1.7 mm.

Straight incision versus horizontal

Total of n =90 patients were in the straight skin incision and n =76 patient in horizontal group. Both groups exhibited similar demographics, comorbidities, mean arterial blood pressure (MAP), presence of a thrill and/or not, laterality, cephalic vein and radial artery diameter ($p > 0.05$). This pattern was also noted in the incidence of maturation (horizontal 76% vs. straight group 62% ($p > 0.05$) and thrombosis (horizontal 13% vs. straight group 18%) ($p > 0.05$). However, higher incidence of juxta-anastomotic stenosis was noted in the conventional group (straight skin incision) once assessed through comparative analysis (horizontal 5.3% vs. straight group 22%) ($p = 0.029$). Subgroup analysis demonstrated similar outcome once assessed through Kaplan-Meier estimator and Log-Rank analysis (log-rank, $p = 0.036$).

DISCUSSION

Since the introduction of the RCAVFs in 1966, various research has been conducted to stratify factors that contribute to the failure of primary FM in RCAVFs. Modification of anastomosis techniques and their angle in conjunction with a better understanding of volumetric parameters (pressure & flow) has been attributed to a higher incidence of primary FM in practice. Maturation is the outcome of positive vascular remodeling, however their impairment could result in early stenosis and/or thrombosis. It has been established that neo-intimal hyperplasia, inward negative and outward positive venous remodeling play a vital role in this process.

It has been recognized that endothelial cells within the vessel wall are important mediators of intracellular signaling. Their exposure to shear stress as a consequence of inflow, stimulates vascular smooth muscle cells and results in intimal hypertrophy and thickening. However, the entire process depends on the distensibility of the cephalic vein and the direction of the intimal hyperplasia [tunica intima (inward) versus tunica media (outward)]. Almost 80% of stenosis in RCAVF fall within 2-3 cm of cephalic vein segment away from the anastomotic site. In conventional (straight) incision as demonstrated in Fig. 1, this section of the vein falls directly under the skin incision site. Thus, extrinsic pressure at this focal point with resultant lack of vein dilatation coupled with inward negative vascular remodeling (intimal thickening) could contribute to a higher incidence of stenosis and if not identified early thrombosis.

Another contributing factor in such circumstances is related to the process of wound healing within the maturation period. It has been noted that during the inflammatory and proliferation phase of wound healing, which could last to up to 60 days, edema, collagen and extracellular matrix deposition at the straight incision site could result in intrinsic tension, extrinsic pressure, impingement and possible focal stenosis of the cephalic vein. In contrast to the conventional skin incision, the outflow component (cephalic vein) of RCAVF remains under the medial flap and not directly under the incision site. This also inhibits the partial untoward twist of the cephalic vein on its longitudinal axis that is commonly associated with extensive mobilisation noted in straight incision. This is mainly due to the fact that in horizontal) - shaped incision, the line of incision exposes both vessels and extensive mobilisation for approximation and anastomosis is not required. The combination of aforementioned factors could explain why a higher incidence of (cephalic vein) stenosis was noted in the straight group both in group ($p= 0.029$) and survival estimates analysis ($p = 0.036$). Furthermore, this process could explain why transverse incision in the past has also demonstrated very poor outcome in practice.

The presence of equal, favorable and comparable prevalence of patient demographics, comorbidities, anesthesia type, laterality, mean arterial blood pressure (MAP) and anatomical variance, along with their exposure to set and replicable perioperative standards has substantially reduced the possible impact of performance bias and their causal link to the end point of maturation, stenosis and thrombosis. Therefore, inference from this observational comparative series is unlikely to have been influenced by any other factor than that of incision type. However, the outcome of this study is only applicable to those RCAVFs within maturation period that were created by continuous anastomosis from heel to base and in end (cephalic vein) to side (radial artery) format with parachute technique. In our unit, we do not use the “the smooth loop technique” of Karmody and/or Tellis technique for anastomosis. The angle and the length of the venotomy and arteriotomy was defined by the longitudinal axis of the artery and was limited to 30-65 degrees and 4 mm respectively [7]. The overall FM of 69% achieved in both groups appears to be in favor and greater than some reports in the literature. Finally, in an era, where failure of FM has significant cost, medical and psychological implications, optimization of primary FM remains vital and every effort should be made to get it done and right the first time.

Strength and limitations

To the best of our knowledge, this is the first study that has assessed the role of two different skin incisions, apart from transverse incision, on the primary functional maturation, stenosis and thrombosis of autogenous RCAVFs in the literature. The outcome of this study suggests

that alternative skin incision (horizontal) is associated with lower incidence of stenosis and could be used in confidence. Due to similar characteristics of the evaluated groups, this observational comparative study remains internally valid and robust.

However, due to the limited number of individuals the power of the study remains an issue and external validity would have benefited greatly from a higher number of patients. It is possible that variance in transducer (ultrasound) choice could also pose some bearing on the internal measurement of the vessel diameters used in the creation of RCAVFs at our center, especially considering that the theoretical axial resolution of a 7 Mhz transducer is approximately 0.3 mm. However, the choice of ultrasound machine and patient arm position should not significantly alter the measurements in practice. This type of incision might prove useful in construction of other types of fistula such as brachiocephalic or high radio cephalic ones.

Conclusion

The outcome of this study suggests that alteration in skin incision from conventional (straight incision) to horizontal could prove beneficial in reducing stenotic complications during RCAVF maturation. Future research might need to consider this an additional factor in their evaluation.

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