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Original Article
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Outcome of Radiocephalic Arteriovenous Fistula Constructed Under Brachial Plexus Block Versus Local Anesthesia: A Randomized Controlled Trial

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Abstract

Backgrounds: *Hemodialysis (HD) is the commonest modality of renal replacement therapy (RRT) which needs vascular access. Ideal vascular access should be well functional, durable, stable, and have fewer complications. An arteriovenous fistula (AVF) is the preferred form of vascular access and is recommended by Kidney Disease Improving Global Outcome (KDIGO) guidelines. Most of the AVFs are constructed under local anesthetic infiltration which has a high failure rate which is about 30-40% for radiocephalic arteriovenous fistula (RCAVF). This study aimed to change the anesthetic technique to brachial plexus block (BPB) for RCAVF creation to improve the primary patency rate and reduce early thrombotic complications.*

Objectives: *The objective was to see the effect of brachial plexus block (BPB) on the outcome of AVF creation by primary patency rate, maturation time, primary functional patency rate, and complications.*

Materials and Method: *This was a randomized controlled trial conducted in the Department of Urology, Bangabandhu Sheikh Mujib Medical University, Dhaka from December 2018 to December 2019. A total of 80 patients were selected from the study population according to inclusion and exclusion criteria. Then divided into two groups by simple random sampling. In the group, A RCAVF constructed under BPB, and group B RCAVF was constructed under LA. The standard operation technique of AVF construction was followed. Evaluation of AVFs was done at 3rd POD, 2nd week, 6th week, and 12th weeks to see the functional status and any complications. Doppler US was done at the 6th week routinely.*

Results: *Among these 80 patients 3 patients were lost from the follow-up, two from group A and one from group B. There was no significant difference in age, sex, comorbidities, and HD status between the groups. There was higher primary patency in group A at 3rd POD and 2nd weeks but was not statistically significant. In the 6th week primary patency in group A was 33/38 (86.8%) and in group B 25/39(64.1%), p=0.033. In the 12th week,*

Keywords: Arteriovenous fistula, Brachial plexus block, Local anaesthesia, Primary patency rate, maturation time.

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primary patency and functional primary patency rate were in group A was 33/38 (86.8%) and in group B 25/39(64.1%), p=0.033 and statistically significant. No significant difference in maturation time between the groups. Thrombosis was the most common complication, 14 in group B and 5 in group A. One BPB was failed but there was no significant complication related to BPB.

Conclusion: *Radiocephalic arteriovenous fistula constructed under brachial plexus block has better primary patency and functional primary patency than local anesthesia at 6th and 12th week. Early thrombotic complications were higher in AVF creation under local anesthetic infiltration. Anaesthesia with BPB can be used for primary radiocephalic AVF construction surgery to improve the outcome of RCAVF fistula and early complications.*

Introduction

The prevalence of CKD in Bangladesh is about 12% among non-communicable diseases and the number of patients with ESRD gradually increasing, most of them are dependent on hemodialysis (HD) (Fatema et al. 2013; Huda et al. 2012). Vascular access is the lifeline for patients with ESRD and HD is the commonest form of RRT. Ideal vascular access provides safe and effective therapy by enabling the removal and return of blood via an extracorporeal circuit (Hoggard 2008). Good quality, functional, and stable vascular access is a major factor in determining the survival of ESRD patients. Autogenous arteriovenous fistula (AVF), prosthetic vascular graft, a central venous catheter (CVC) are the modalities of vascular access for HD. An autogenous AVF is recommended as the optimal technique (Fluck and Kumwendab 2011).

The autogenous AVF is the preferred form of vascular access for hemodialysis, delivering superior long-term patency with lower morbidity, hospitalization, and costs relative to prosthetic grafts or hemodialysis catheters (Hoggard 2008).

However, the creation of functional autogenous AVF is very challenging as the primary failure rate is 28-37% and the patency rate at one year 50-63% (Al-Jaishi et al. 2014). The causes of early failure are thrombosis, anastomotic stenosis, poor blood flow, and vascular spasm. The likelihood of failure is affected by the preoperative arterial and venous diameters, arterial inflow, perioperative arterial spasm, and reduced early postoperative blood flow through the arteriovenous fistulae (Lin PH et al. 2005).

Regional anesthesia, such as a brachial plexus block (BPB), involves a targeted injection of a local anesthetic to attain the desired effect (Jankovic 2015). This specifically blocks the motor, sensory, and sympathetic nerves that supply the operative site, avoiding the need for general anesthesia (Shemesh et al. 2014).

Regional blocks produce a sympathectomy-like effect - vasodilation, reduce pulsatility index (PI) and increase blood flow through arteriovenous anastomosis (AVA) during the perioperative period, thus leads to decrease early thrombus formation and maturation time (Shemesh et al. 2006). Moreover, the use of BPB can lead to improving site selection as a more distal site can be used for AVF creation and increase the opportunity for AVF creation (Laskowski et al. 2007).

On the other hand, arterial and venous spasm, local edema, the infection is more common with local anesthetic (LA) infiltration than with regional (Konner et al. 2003). Although general anesthesia increases intraoperative vasodilatation its effect ceases on recovery from anesthesia and it is associated with systemic hypotension and increased risk of cardio-respiratory complications in patients with ESRD (Mouquet et al. 1989).

Several observational studies and clinical trials have previously demonstrated that, compared to local anesthetic infiltration, brachial plexus block (BPB) results in a better early patency rate, maturation, and fewer thrombotic complications. (Shemesh D et al. 2003; Aitken E et al. 2016; Monte L et al. 2011). But still, now no strong conclusive evidence is available regarding the optimum anesthetic technique for AVF creation.

This study aimed to evaluate the role of BPB in mitigating the factors responsible for the early failure of AVF and compare the effectiveness of BPB in the outcome of radiocephalic AVF fistula in comparison to local anaesthesia.

Materials and methods:

This was a randomized controlled trial conducted in the department of urology, Bangabandhu Sheikh Mujib

Medical University (BSMMU), Dhaka from December 2018 to December 2019. The study population was all the patients with ESRD attended to urology OPD or referred to the department of urology for arteriovenous fistula construction. All ESRD patients 18 to 70 years old who need primary radiocephalic arteriovenous fistula construction were study subjects. Patients having previously failed AVF, radial artery and cephalic vein diameter <1.8mm, ipsilateral upper limb ipsilateral paralysis or paraplegia, central vein stenosis, diabetes mellitus, and Congestive cardiac failure were excluded from the study.

Study subjects were allocated with a code number which was random with computer-generated software and divided into two groups (experimental and control groups). In group A radiocephalic arteriovenous fistula was constructed under BPB (experimental group) and in group B radiocephalic arteriovenous fistula was constructed under LA (control group).

Ethical clearance for the study was taken from the Institutional Review Board of BSMMU before the commencement of this study. The aim and objectives of the study along with its procedure, risks, and benefits of this study were explained to the study subjects in an easily understandable local language. Written informed consent was taken from all the study subjects without exploiting any of their weakness.

Patients were assessed preoperatively by history, physical examination, investigations-CBC, BT, CT, PT, APTT, and RBS. Duplex ultrasound assessment of upper limb vessels, measurement of diameter with vein mapping were done. A BPBs were given through an infraclavicular approach with ultrasound guidance with a 1:1 mixture of 0·5% L-bupivacaine and 1·5% lidocaine with epinephrine (1 in 200000), the maximum volume of 40 ml. The sensory and motor block were recorded to assess the success of BPB. If sensory blocks were inadequate within 20 minutes or need of intravenous opioid analgesia for operative site discomfort, the BPB was recorded as a failed block.LA infiltration was given by the operating surgeon with a combination of 0·5% L-bupivacaine and 1% lidocaine subcutaneously immediately before the commencement of surgery.

Surgeons followed a standard operating technique RCAVF creation. A longitudinal skin incision was made above the wrist joint. The cephalic vein was dissected and skeletonized. Visible branches were ligated and divided. The vein was divided ligating the distal segment and the proximal segment was spatulated and flushed with heparinized saline. The surgeon then dissected the artery and controlled it with bulldog clamps. The size of the arteriotomy was at the surgeon's discretion, based on risks and benefits for the individual patient.

An end-to-side anastomosis of the vein to the artery was performed using continuous 6.0 prolene. Procedures were done as day-case surgery. Immediately after the procedure patency of the fistulas was assessed by palpating the thrill and auscultating the machinery murmur. After several hours of close observation, patients were discharged with advice regarding how to take care of AVF, operated limb, take medications, and about the emergency contact (any time) if any complication arises. Follow-up was done on the 3rd postoperative day (POD), 14th POD, and 6th week with CDUS. If thrill or murmur was absent or equivocal or fistula is not suitable for dialysis it was considered failed.

According to code number data were entered in the computer as a tabulated sheet. Results were analyzed using SPSS Statistics v.26 (IBM Analytics, Armonk, NY, USA). A student's t-test was used to compare continuous data and a ÷^{2} test (Chi-square test) or Fisher's exact test to compare categorical data. P< 0.05 was considered statistically significant.

Results

A total of 80 patients were equally divided into two groups. Two patients from group A and one patient from group B did not continue to follow up. During the study period, a total of 77 patients were included, 38 were in the LA group (group A) and 39 were in the BPB group (group B). The age range in group A 19-70 years, in group B 23-69 years. There was no significant difference in nondependent variables among the groups like sex, hypertension, IHD, CVD, and hemodialysis (HD).

On the 3rd postoperative day and 2nd week in group A, 33 (86.8%) patients and group B, 27 (69.2%) patients maintain primary patency. There was no significant statistical difference between the groups (p=0.098). In the 6Th week, in group A, 33 (86.8%) patients had primary patency while in group B, 25 (64.1%) patients were statistically significant(p=0.033). In the 12 weeks, in group A, 33 (86.8%) patients had functional primary patency while in group B, 25 (64.1%). A significant statistical difference between the groups regarding primary patency in the 6th week (p=0.033).

Table 1: *Primary Patency*

Primary patency	BPB group (%)	LA group (%)	Statistics
3rd POD	33/38 (86.8)	27/39 (69.2)	p=0.098
2nd week	33/38 (86.8)	27/39 (69.2)	p=0.098
6th week	33/38 (86.8)	25/39 (64.1)	p=0.033

Functional primary patency at 12 weeks was also significant when 33/38 in group A and 25/39 in group B underwent successful hemodialysis and were significant. Maturation time in group A was 6 weeks and 22/25 patients in group B attain maturation. In group A, 6 (15.8%) patients and group B, 14 (35.9%) patients had complications.

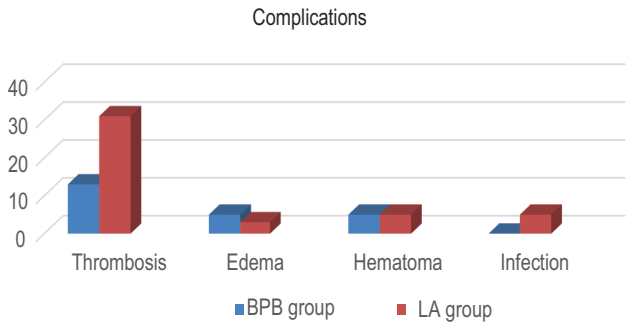

Figure 1: *Complications of fistula construction*

Thrombosis, hematoma, edema, and infections were complications. In group A, 5 (13.2%) patients developed thrombosis and in group B, 12 (30.8%) patients developed thrombosis which was the most frequently occurring complication.

Discussion

Early failure is the most challenging issue in arteriovenous fistula creation and thrombosis is the main cause of failure. In this study, no significant difference was found in nondependent variables between the study groups. Smith, Gohil & charter (2012) published a review article on factors' effect on AVF patency, they concluded age does not affect fistula patency among patients under 70 years. Masengu, Maxwell & Hanko (2016) found in their study that the female gender had a higher rate of AVF failure compared to males is supposed to be due to more subcutaneous fat, thinner vessel wall, and comorbidities.

In the 6th week, in group A, 33 (86.8%) vs 25 (64.1%) in group B and statistically significant. In the 12th week, primary functional patency was similar in both groups, and by this time MHD was successfully done using these RCAVFs. This result shows that initially, the immediate primary patency rate was higher in group A but statistically not significant. Two patients in group B developed thrombosis and fistulas were nonfunctional. At six- and twelve-weeks patency rate was much higher in fistula constructed under BPB than LA and was statistically significant. Primary patency at six weeks is the decisive factor for the determination of long-term AVF patency, those patents at this time eventually become functional and can be used for HD (Robbin et al. 2017).

These findings are consistent with other randomized trials. Aitken et al. (2016) conducted RCT on 126 patients, age >18 years, mean age 60.8 years in BPB and 59.5 years in LA group, radiocephalic AVF on 51 patients, and brachiocephalic AVF on 75 patients. In radiocephalic AVF primary patency at 3 months was higher in patients having their arteriovenous fistulae created under BPB than under local anesthesia (20 [77%] of 26 patients vs 12 [48%] of 25 patients (p=0·03). Meena et al. (2015) studied over 60 patients, age 18-60 years, randomly selected 30 in BPB, and 30 in the LA infiltration group. They found the primary patency rate was 100% in the BPB group whereas there was a 10% fistula failure rate in the LA infiltration group.

The higher patency rate of radiocephalic AVF constructed under brachial plexus block is due to the sympathetic blockade effect of regional anesthesia which increases the vascular diameter and blood flow during the perioperative period and reduces pulsatility index (PI) (Shemesh et al. 2006). Aitken et al. (2016) in their study (previously mentioned) also assessed the effect of BPB on vascular diameter and blood flow by measuring pre and post-anesthetic changes with doppler ultrasound. They found the brachial arterial flow, cephalic vein diameter, and basilic vein diameters were significantly increased after BPB.

Shahin et al. (2011) compared the effects of BPB, and LA on blood flow in the radial artery and AVF during the early and late postoperative periods. After the brachial block, the preoperative radial arterial flow was significantly increased than LA. Blood flow in the fistula, at 3 hours, 7 days, and 8 weeks postoperatively, was also greater in the BPB group vs LA group. Monte et al. (2011) also reported a similar type of change in blood flow and the diameter of upper arm vessels after BPB. In this study, we could not assess vascular change and the flow rate during the perioperative period.

Fistula maturation is a complex process, many microscopic and macroscopic structural and functional changes cause arterialization of a vein, increase diameter and establish fistula type laminar blood flow usually over 4-8 weeks, all these changes are facilitated by BPB (Konner, Daniel & Ritz 2003; Hammes 2015). In this study at 6th week, all patients in group A, 22 out of 25 (88.0%) in group B attained maturation. In this study, in group A, 6 (15.8%) patients had complications while in group B, 14 (35.9%) patients had complications. Thrombosis at the fistula site was the most common complication and more in group B. The most common causes of early thrombosis after AVF construction are hypotension, vascular spasm, stenosis of the anastomotic site (Kim et al. 2001, Konner et al. 2003).

Brachial plexus block can be attained by both supraclavicular, infraclavicular, and axillary routes for distal forearm surgery successfully and extremely safe, ultrasound (US) or nerve stimulator guidance increase both levels of success and safety (Chin 2015, 378). There were no BPB related complications in this study.

Conclusion:

Radiocephalic arteriovenous fistula constructed under brachial plexus block (BPB) in comparison to radiocephalic arteriovenous fistula constructed under local anesthesia (LA) has a better primary patency rate at 3 months and fewer postoperative complications like thrombosis. BPB can be a feasible technique to attain a successful, well-matured AVF that can reduce stress, morbidity, recurrent surgery, and improve the quality of life of a patient with ESRD and can be used for a prolonged period.

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