

Comparison of Supraclavicular Brachial Plexus Block and Local Anaesthetic Infiltration in Arteriovenous Fistula Surgeries

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Abstract

Introduction: Surgical construction of an arteriovenous fistula (AVF) is the most common procedure performed to gain access for hemodialysis in patients with end stage renal disease. With over 30% failure rate in arteriovenous fistula surgeries performed under local anaesthesia, brachial plexus block (BPB) is preferred as it improves the duplex sonography parameters, which may reduce the failure rate. However, the studies on the role of brachial plexus block in improving the AVF outcome are limited. We, therefore, evaluated the effectiveness of ultrasound guided brachial plexus block against the traditional local infiltration (LI) in AV fistula surgeries. **Methods:** 200 patients were randomly allocated to receive either Local Infiltration; Group I (LI-G) at the surgical site or supraclavicular brachial plexus block; Group II (BPB-G). The Doppler assessment of vessels was done before and after the block, at fixed time intervals and compared between the two groups. Intergroup comparison was also done with respect to the need for supplemental analgesics intraoperatively and the duration of postoperative analgesia. All the surgeries were performed by the same anesthetist and the surgeon. **Results:** The primary patency rates at three months were 100 percent in the brachial plexus block group versus 95 percent in the local infiltration group. The difference, however, was not significant statistically. Post anaesthesia, the brachial artery diameter was increased significantly in the BPB group vs LI group (mean difference [MD], 0.11; 95 % confidence interval [CI]: 0.00-0.22; p value 0.03). There was significant increase in radial artery flow in BPB group than the LI group (MD, 8.27; 95 % CI: -9.83 - -6.85; p value <0.001). The brachial plexus block significantly enhanced the duration of perioperative analgesia (MD, -339.35; 95 % CI: -349.02 - -329.68; p value <0.001) with minimal need for supplementary intravenous (IV) analgesics. **Conclusion:** When used for arteriovenous fistula access surgeries, supraclavicular brachial plexus block significantly improves the arteriovenous fistula flow characteristics as compared with local infiltration and provides additional advantage of pain relief and temporary sympathectomy.

Keywords: Arteriovenous Fistula, Regional Anaesthesia Block, Local Infiltration, Ultrasound Guided, Renal Failure

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Introduction

Chronic renal failure affects more than 1 million people in India per year [1]. Patients with chronic renal failure are dependent on dialysis to achieve better quality of life. Constructing an AVF is the most dependable method to gain vascular access for long term hemodialysis. Approximately 30% of AVF fail at an initial stage mostly because of inadequate blood flow or thrombosis [2-6]. The outcome of fistula construction depends on preoperative arterial and venous diameters as well as intra operative blood flow. Maintaining adequate blood flow intra and post operatively prevents thrombosis and hence, fistula failure. Local anaesthetic infiltration causes arterial and venous spasm which further reduces blood flow. Ultrasound

guided brachial plexus block because of its sympathectomy like effect, achieves better vasodilation, thereby, improving intra operative conditions and post operative fistula maturation. The USG guided brachial plexus block has improved the efficacy of regional anaesthesia during upper limb surgeries. For AVF, the brachial plexus block improves blood flow through vessels by causing vasodilation by sympathetic blockade and does not affect hemodynamics of the patient [7,8]. The USG guided technique has increased the success rate of brachial plexus block with better visualization and safety. It decreases the primary failure rate after 3 months, thereby, reducing the number of repeat procedures [9].

The main aim of the study was to assess operative conditions, pain relief, regional hemodynamic changes and complications rate during AVF construction, using supraclavicular brachial plexus block against traditional local infiltration.

Material and Methods

Following approval of the study protocol by the Ethics Committee of the institute, a written informed consent was obtained from all the enrolled patients, after providing thorough explanation of the procedure. Present study was a prospective, observational study

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conducted in Department of Anaesthesiology, National Institute of Medical Sciences & Research, Jaipur, Rajasthan (India) enrolling 200 patients, aged 18 to 75 years, scheduled for creation of arteriovenous fistula to undergo hemodialysis. Patients with comorbidities such as diabetes, hypertension and coronary artery disease were also included. Exclusion criteria included patients with coagulopathy, allergy to local anesthetics, revision of previously blocked fistula and those who refused to participate in the study. Patients were randomly allocated to the two groups. Baseline monitors were attached in the operating room. The diameters of brachial artery, radial artery, cephalic vein and radial artery blood flow were measured before the procedure using ultrasonography. Group I (Local Infiltration group) patients were given local infiltration at the incision site with Lignocaine 2% by the surgeon. In Group II (Brachial Plexus Block Group) patients, Supraclavicular Brachial Plexus Block was performed under ultrasonographic guidance and 15 ml of (0.375%) Ropivacaine was injected. The supraclavicular block was performed with ultrasound, using 5 - 12 MHz linear transducer. The hypoechoic Brachial Plexus was identified lateral and superficial to the subclavian artery. A 23 G spinal needle was directed towards the lateral corner of subclavian artery, superior to the first rib. After confirming the position of the needle close to the brachial plexus, the local anaesthetic solution was injected with frequent aspirations, till the whole neural plexus was encircled. Vasodilatation in the arm was observed and recorded. Sensorimotor effect was checked 15 minutes after the block and was considered complete if there was no response to pinprick and motor power was assessed by the loss of voluntary movement in the arm. If the block failed, local anaesthetic was infiltrated at the surgical site and the case was excluded from the study. The sonographic measurements of the vessels and the blood flow in the radial artery was assessed before and 10 minutes after the block, by an observer who was masked to the technique performed. Supplementary intravenous analgesics were given, if the patients experienced pain during the procedure. Fistula was also tested for thrill, compressibility, pulsatility and presence of bruit at various time intervals. Postoperatively, the graft was assessed for maturation and

complications such as thrombosis, bleeding, infections or stenosis. A record of the duration of analgesia in the post operative period and the subsequent need for analgesics was maintained. The primary outcome of the study was the quality of surgical field provided by the anaesthetic technique and the patency of the fistula, within an hour of the procedure, as well as, three months after the procedure. Secondary end points were evaluating the effectiveness of the block in terms of procedural pain, motor blockade, use of supplementary analgesics and sedatives, duration of analgesia and complication if any.

Observations and Results

The patients in both the groups did not differ significantly with respect to demographic profiles, coexisting diseases, as well as the arterial and venous parameters measured prior to fistula creation. Quantitative variables were described as mean±standard deviation.

Independent sample- t test was used to compare mean between the two groups. P value of less than 0.05 was deemed significant.

There was no significant difference in the vascular parameters between the two groups before anaesthesia ($P > .05$) but after the block, the mean radial artery flow increased by 8.27 ml/min ($P < .05$), than the local infiltration group. The mean increase in radial artery diameter was 0.10 mm ($P < .05$), whereas the mean cephalic vein diameter increased by 0.19 mm ($P < .05$). Satisfactory vasodilatation was achieved in all the patients in brachial plexus block group due to its sympathetomy like effects, thus improving the operative field. Intraoperative requirement of additional opioids and sedatives was negligible (2 patients) in the brachial plexus block group while 19 patients in the local infiltration group needed analgesics to reduce surgical pain. The patency of the fistula in the postoperative period was checked by palpating for thrill one hour after surgery and was present in all the patients of both the groups. The brachial plexus block group had 100% patency at three months, evaluated by ultrasonography, while there was 5% failure rate in the local infiltration group. The difference, however, was not significant.

Duration of postoperative analgesia was significantly higher in the group that received regional anaesthesia (405vs 65.65, $P \text{ value} < 0.05$).

Table 1: Demographic data and coexisting diseases of patients

Variables	LI-G (n=100)	BPB-G (n=100)	P-value
Age (years)	48.77± 14.29	48.52± 12.76	0.77
Numbers of males	54	60	0.39
Coexisting diseases			
Diabetes	48	44	0.57
Hypertension	62	60	0.77
Coronary artery disease	13	22	0.09

Table 2: Doppler Observations

	LI-G (n=100)	BPB-G (n=100)	MD*	P-value	95% confidence interval of difference	
					Lower	Upper
Cephalic Vein diameter (mm) before anaesthesia	3.50±0.19	3.45±0.27	0.05	0.14	-0.02	0.11
Cephalic Vein diameter after anaesthesia (mm)	3.63±0.18	3.82 ±0.37	0.19	0.001	0.27	0.11
Radial Artery internal diameter before anaesthesia (mm)	2.48±0.21	2.54±0.21	0.06	0.08	0.01	0.04
Radial Artery diameter after anaesthesia (mm)	2.68±0.24	2.78±0.23	0.10	0.002	-0.16	-0.04
Brachial Artery diameter before anaesthesia (mm)	3.02±0.32	3.0±0.31	0.02	0.58	-0.11	0.06
Brachial Artery diameter after anaesthesia (mm)	3.28±0.33	3.36±0.39	0.11	0.03	0.00	0.22
Radial Artery blood flow before anaesthesia (ml/min.)	39.02±5.64	38.36±5.08	0.66	0.45	-0.51	1.71
Radial Artery blood flow after anaesthesia (ml/min.)	44.54±5.73	52.81±8.14	8.27	<0.001	-9.83	-6.85

*MD: Mean difference

Discussion

AVF is considered as the best modality to procure vascular access for long term hemodialysis. The outcome of fistula creation is affected by several surgical and patient related factors. The choice of regional anaesthetic technique may modify certain regional hemodynamic parameters, thus, influencing surgical as well as patient-oriented outcomes.

Regional anaesthesia blocks provide good quality anaesthesia and analgesia, hence, making it feasible to avoid airway manipulation and hemodynamic effects of general anaesthesia.

During vascular surgeries, spasm at the surgical site is likely due to increased sympathetic tone and handling of vessels, which impairs blood flow, thus, leading to early thrombosis and failure of fistula.

This study has demonstrated the immediate increase in the vessel diameter, blood flow and post operative patency of fistula after brachial plexus block [10]. The ultrasound guided brachial plexus block achieves better vasodilation [11,12], improved intraoperative conditions [13], better post operative fistula patency and functioning as compared to local anaesthetic infiltration [14,15].

Malinzak and Gan suggested that regional anaesthesia techniques facilitate vascular access surgeries by increase in vasodilation, increase in fistula blood flow, decrease in maturation time and have no effect on blood pressure and heart rate [16].

In the present study, we aimed to compare operative conditions, regional vascular parameters, vascular patency and complications following arteriovenous fistula surgeries between patients receiving brachial plexus block and local anaesthetic infiltration. Effective brachial plexus block was achieved with the help of ultrasound guidance with adequate sensorimotor blockade resulting in improved intraoperative conditions. There was considerable vasodilatation in the upper limb immediately after the block. The results obtained showed no significant difference in the patency between local anaesthesia and supraclavicular block group in the immediate postoperative period. However, radial artery blood flow and diameter of the vessels were considerably higher in the patients under supraclavicular block.

Mouquet et al. studied the effect of four different anaesthesia techniques (local infiltration, brachial plexus block, isoflurane and halothane) on blood flow through arteriovenous fistula during early postoperative period and concluded that the brachial plexus block provided the greatest blood flow with minimum hemodynamic changes [17].

Ebert et al. suggested an additional and immediate effect of the axillary BPB with a significant rise in blood velocity and increase in cross-section area. The average arterial peak blood flow after the plexus block was 1.9 times than before, while, on the venous side, the block effect caused an average increase of the blood flow to 8.6 times than before the block [18].

The sympathetomy like effects of brachial plexus block were also confirmed by Shamesh et al, who found out that pulsatility index (an indicator of sympathetic change), remained low for five hours after the brachial plexus block, as compared to other anaesthetic changes [19].

Regional anesthesia has proved to be better for postoperative analgesia and provided faster recovery from anesthesia [20-22].

Supraclavicular brachial plexus block carries the potential risk of complications such as neuropathy, pneumothorax, recurrent laryngeal nerve palsy, hematoma, infection and systemic toxicity [23]. In our patients, there were no significant adverse events related to the procedure except for self-limiting recurrent laryngeal nerve palsy in one patient. The hyperdynamic circulation in chronic kidney disease patients increases absorption of local anesthetics into the bloodstream, which results in high plasma concentrations leading to toxicity [24].

However, we did not compare the impact of anaesthetic technique on the duration of surgery and whether the vasodilatory properties of brachial plexus block assist with arteriovenous fistula site selection.

Reynolds et al. demonstrated 17% modification of operative plans in 30 patients operated under supraclavicular brachial plexus block [25].

Conclusion

We conclude that patients requiring vascular access procedures are likely to benefit from regional anaesthetic block technique, as it yields more favourable veins, improves various intraoperative surgical parameters and also confers benefits post operatively.

References:

1. Modi GK, Jha V. The incidence of end-stage renal disease in India: A population-based study. *Kidney Int.* 2006; 70:2131-3.
2. Palder SB, Kirkman RL, Whittemore AD, Hakim RM, Lazarus JM, Tilney NL. Vascular access for hemodialysis. Patency rates and results of revision. *Ann Surg.* 1985; 202(2):235-9.
3. Miller PE, Tolwani A, Luscly CP, Deierhoi MH, Bailey R, Redden DT, Allon M. Predictors of adequacy of arteriovenous fistulas in hemodialysis patients. *Kidney Int.* 1999; 56:275-80.
4. Allon M, Lockhart ME, Lilly RZ, Gallichio MH, Young CJ, Barker J, Deierhoi MH, Robbin ML. Effect of preoperative sonographic mapping on vascular access outcomes in hemodialysis patients. *Kidney Int.* 2001; 60:2013-20.
5. Asif A, Cherla G, Merrill D, Cipleu CD, Briones P, Pennell P. Conversion of tunneled hemodialysis catheter consigned patients to arteriovenous fistula. *Kidney Int.* 2005; 67:2399-407.
6. Won T, Jang JW, Lee S, Han JJ, Park YS, Ahn JH. Effects of intraoperative blood flow on the early patency of radiocephalic fistulas. *Ann Vasc Surg.* 2000; 14:468-72.
7. J. Rodriguez, O. Quintela, M. Lopez Rivadula, M. Barcena, C. Diz, J. Alvarez. High doses of mepivacaine for brachial plexus block in patients with end-stage chronic renal failure: A pilot study *Eur J Anesthesiol.* 2001; 18:171-6.
8. B. Ebert, R. Braunschweig, P. Reill. Quantification of variations in arm perfusion after plexus anesthesia with color Doppler sonography. *Anaesthetist.* 1995; 44:859-62.
9. Chan VW, Perlas A, Rawson R, Odukoya O. Ultrasound-guided supraclavicular brachial plexus block. *Anesth Analg.* 2003; 97:1514-7.
10. Alsalti RA, el-Dawlatly AA, al-Salman M, Jomaa S, Amro K, Dweiri MA et al. Arteriovenous fistula in chronic renal failure patients: Comparison between three different anesthetic techniques. *Middle East J Anaesthesiol.* 1999; 15:305-14.
11. Li J, Karmakar MK, Li X, Kwok WH, Ngan Kee WD. Regional hemodynamic changes after an axillary brachial plexus block: A pulsed-wave doppler ultrasound study. *Reg Anesth Pain Med.* 2012; 37:111-8.
12. Sahin L, Gul R, Mizrak A, Deniz H, Sahin M, Koruk S et al. Ultrasound-guided infraclavicular brachial plexus block enhances postoperative blood flow in arteriovenous fistulas. *J Vasc Surg.* 2011; 54:749-53.
13. Laskowski IA, Muhs B, Rockman CR, Adelman MA, Ranson M, Cayne NS et al. Regional nerve block allows for optimization of planning in the creation of arteriovenous access for hemodialysis by improving superficial venous dilatation. *Ann Vasc Surg.* 2007; 21:730.
14. Robbin ML, Greene T, Cheung AK, Allon M, Berceli SA, Kaufman JS et al. Arteriovenous fistula development in the first 6 weeks after creation. *Radiology.* 2016; 279:620-9.
15. Nofal WH, El Fawal SM, Shoukry AA, Sabek E, Malak W. Ultrasound-guided axillary brachial plexus block versus local infiltration anesthesia for arteriovenous fistula creation at the forearm for hemodialysis in patients with chronic renal failure. *Saudi J Anaesth.* 2017; 11:77-82
16. Malinzak EB, Gan TJ. Regional anesthesia for vascular access surgery. *Anesth Analg.* 2009; 109:976-80.

17. Mouquet C, Bitker MO, Bailliart O, Rottembourg J, Clergue F, Montejo LS et al. Anesthesia for creation of a forearm fistula in patients with endstage renal failure. *Anesthesiology*. 1989; 70:909–14.
18. Ebert B, Braunschweig R, Reill P. Quantification of variations in arm perfusion after plexus anesthesia with color Doppler sonography. *Anaesthesist*. 1995; 44:859–62.
19. Shemesh D, Olsha O, Orkin D, Raveh D, Goldin I, Reichenstein Y, Zigelman C. Sympathectomy-like effects of brachial plexus block in arteriovenous access surgery. *Ultrasound Med Biol*. 2006; 32:817–2.
20. Hingorani AP, Ascher E, Gupta P, Alam S, Marks N, Schutzer RW, Mulyala M, Shiferson A, Yorkovich W, Jacob T, Salles-Cunha S. Regional anesthesia: preferred technique for venodilatation in the creation of upper extremity arteriovenous fistulae. *Vascular*. 2006; 14:23–6.
21. Solomonson MD, Johnson ME, Ilstrup D. Risk factors in patients having surgery to create an arteriovenous fistula. *Anesth Analg*. 1994; 79:694–700.
22. Leonard IE, Chinappa V. Vascular access procedures for haemodialysis—potential hazard of regional anaesthesia. *Anaesthesia*. 2001; 56:917–8.
23. Wedel DJ, Horlocker TT. Nerve blocks. In: Miller RD, Fleisher LA, eds. *Miller's anesthesia*. 6th ed. Philadelphia, PA: Elsevier Churchill Livingstone, 2005, 1686–95.
24. McEllistrem RF, Schell J, O'Malley K, O'Toole D, Cunningham AJ. Interscalene brachial plexus blockade with lidocaine in chronic renal failure - a pharmacokinetic study. *Can J Anaesth*. 1989; 36:59–63.
25. TS Reynolds, KM Kim, R Dukkupati, TH Nguyen, I Julka, C Kakazu et al. Pre-operative regional block anesthesia enhances operative strategy for arteriovenous fistula creation *J Vasc Access*. 2011; 12:336-34.

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