Observational study of the efficacy of supraclavicular brachial plexus block for arteriovenous fistula creation

Selvakumar Palaniappan, Venkatesh Subbiah, V Raja Gopalan, Poornima Vijaya Kumar, R John Santa Vinothan
Departments of Anaesthesia, *General Surgery and †Vascular Surgery, Velammal Medical College, Madurai, Tamil Nadu, India

ABSTRACT

Background and Aims: Arteriovenous (AV) fistula surgery is commonly performed for AV access for hemodialysis. However, the ideal anaesthetic technique of choice remains debated. We aimed to assess operative conditions, vascular patency, and complication rate following AV fistula surgery with isolated brachial plexus block among end-stage renal disease (ESRD) patients.

Methods: This prospective, observational study included 214 patients undergoing AV fistula surgery under isolated supraclavicular brachial plexus block between January and December 2017. The diameters of the vessels both before and after the block, and the patency of the AV fistula in the immediate postoperative period and after 3 months were assessed using ultrasound Doppler. The change in the vessel diameter both before and after block was compared using independent sample t-test.

Results: The mean brachial artery diameter increased by 0.09 mm (P = 0.002), and cephalic vein diameter at elbow, radial artery, and cephalic vein at wrist diameters increased by 0.5 mm (P < 0.001), 0.08 mm (P = 0.031), and 0.48 mm (P < 0.001), respectively. Overall, 93.45% had immediate patency, 85.51% had primary, and 47.19% had functional patency at 3 months. In the brachiocephalic group, 96.24% had immediate patency, 87.21% had primary, and 27.06% had functional patency at 3 months. Among the radiocephalic group, 91.35% had immediate patency, 82.71% had primary patency, and 71.60% had functional patency at 3 months.

Conclusion: Ultrasound-guided isolated brachial plexus block results in good vasodilation and achieves good immediate and long-term patency in AV fistula surgery.

Key words: Brachial plexus block, end-stage renal disease, fistula, supraclavicular

INTRODUCTION

Following the “fistula fist” recommendation by the national vascular access improvement initiative,[1] arteriovenous (AV) fistula surgery has become the most common surgical procedure performed to achieve AV access for hemodialysis. Among the different modalities of anaesthesia, ultrasound-guided brachial plexus block has been reported to achieve better vasodilation[2,3] and improve operating conditions[4] and postoperative fistula functioning.[5] Standard recommendations have not evolved to guide the choice of anaesthesia in these patients due to a scarcity of studies. Hence, the current study was conducted to assess the operative conditions, vascular patency, and complication rate following brachial plexus block in end-stage renal disease (ESRD) patients undergoing AV fistula surgery.

METHODS

This was a prospective observational study conducted in the department of anaesthesia and vascular
surgery of a tertiary care teaching hospital. The data
collection for the study was conducted between
January and December 2017. The study was approved
by the institutional human ethics committee, and
written informed consent was obtained from all the
participants.

The study population included all adult patients aged
above 18 years, of both genders, ASA physical status
III, ESRD stage II to IV, and on dialysis who underwent
AV fistula surgery under supraclavicular brachial
plexus block. All ESRD patients with comorbidities
such as diabetes, hypertension, and ischemic heart
disease (IHD) were included in the study. Patients
who had a history of coagulation disorders, patients
who did not have ideal vessels to perform AV fistula
surgeries, and patients with a history of failed fistula
were excluded from the study.

The diameters of brachial artery, radial artery, and
cephalic vein were measured before the block, with
the help of ultrasound Doppler. Supraclavicular approach
was used for brachial plexus block. GE LOGIQ
e (12 Linear probe) (GE medical systems (China) Co.
Ltd, Jiangsu, P. R. China) was used for ultrasound
guidance. The anaesthetic medication used for the
block was Inj. lignocaine 2% with adrenaline (15 ml),
combined with 15 ml of bupivacaine (0.5%).
Subsequently, sensory, and motor blockade of the
hand, forearm, and distal arm was monitored. Onset
of anaesthesia was assessed using the pin prick
method. Onset of motor block was clinically assessed
by assessing the motor power. Vasodilatation was
noted immediately in the arm and forearm by visual
inspection. Heart rate, blood pressure, respiratory
rate, and oxygen saturation were monitored with GE
multiparameter monitor (GE medical systems (China)
Co. Ltd, Jiangsu, P. R. China). After successful block,
which was defined as absence of pain on pin prick as
well as absence of voluntary movement, the vessel
diameters were measured again using the ultrasound
Doppler. After positioning the patient, with strict
aseptic precaution, through a transverse incision at the
elbow region, brachial artery and cephalic vein were
identified looped and controlled. Inj. Heparin 2500
U IV Stat given. Through an arteriotomy wound, end
to end anastomosis was done with 7’0 prolene. After
attaining of perfect haemostasis wound was closed in
layers and dressing done.

Fistula was then palpated for thrill, compressibility,
pulsatile/no pulsatile. Graft was then auscultated
for the presence of bruit. A continuous low-pitched
bruit was considered normal, whereas a high-pitched
bruit or whistling sound was considered as an
indication of stenosis. The patency of the AV fistula
in the immediate postoperative period was also
assessed by ultrasound Doppler. A vascular surgeon
inspected the graft to check for the presence of any
infection, bruising, or hematoma along the incision
line, as well as for the presence of dilated veins over
the fistula before discharge. During the postoperative
follow-up, graft was assessed for maturation and
presence of any complications. Complications
such as thrombosis, bleeding, infection, stenosis,
aneurysm, and failure of maturation were
immediately addressed. Patients were advised to
perform isometric exercises to improve blood flow
and thus to make the vein more prominent. All
patients were followed for 3 months to assess the
patency of the fistula using ultrasound Doppler.

All quantitative variables were checked for normal
distribution using visual inspection of histograms and
normality Q–Q plots. The Shapiro–Wilk test P values
were also analysed. Descriptive analysis of normally
distributed quantitative variables was done by mean
and standard deviation. The categorical variables
were summarised by frequency and proportion. The
mean change in the vessel diameter before and after
the block was assessed by independent-sample t-test.
P value <0.05 was considered statistically significant.

The sample size was calculated assuming the expected
proportion of 3 months patency of the fistula as 84%,
according to the study by Aitken et al.,[6] with 5%
absolute precision and 95% confidence level. As per
the above mentioned sample size, the required number
of study subjects was 207. To account for a loss to
follow-up of approximately 10%, it was decided to
add another 21 subjects to the study, making the total
required sample size 228. The final study included 230
subjects, out of which 16 were lost to follow-up due
to various reasons and the final analysis included 214
subjects. All the study subjects were recruited into the
study by convenient sampling till the required sample
size was reached.

RESULTS

A total of 214 patients undergoing AV fistula surgery
were included in the final analysis. The demographic
profile, distribution of patients, and comorbidities are
described in Table 1.
All the vessels showed significant increase in diameter following the block. Blood flow in the brachial artery also showed significant enhancement following the block. The mean brachial artery diameter increased by 0.09 mm from the baseline (P-value 0.002). The mean cephalic vein diameter at the elbow increased by 0.50 mm (P value < 0.001). The mean radial artery diameter and mean cephalic vein diameter at wrist showed increases of 0.08 mm and 0.48 mm, respectively, following the block. The flow of brachial artery increased by 13.53 ml/Min (P value <0.001) [Table 2].

The key primary outcomes are summarised in Table 3. Immediate patency in the overall group and in both the brachiocephalic and radiocephalic groups was more than 90%. Primary patency levels at 3 months were also very high in both the brachiocephalic and radiocephalic groups. Functional patency at 3 months was relatively much higher in the radiocephalic group (71.60%), but was very low in the brachiocephalic group (27.06%).

**DISCUSSION**

The current study has reported the immediate change in the vessel diameter, blood flow, and postoperative fistula patency at 3-month follow-up in a group of Indian ESRD patients undergoing fistula surgery under brachial plexus block. The regional block, most commonly performed as ultrasound-guided brachial plexus block, has been reported to achieve better vasodilation, improved operation conditions, and better postoperative fistula functioning compared to local anaesthesia. Hence, regional anaesthesia, along with intraoperative ultrasound, while performing AV access surgery may result in improved site selection and increased opportunity for AV fistula creation. In the current study, effective blockade was achieved with required sensory and motor blockade in cases where the vascular parameters were assessed as per the protocol.

In the current study, we have observed statistically significant increase in vessel diameter both at the elbow and at the wrist immediately following the block. The blood flow also increased significantly in the brachial artery. Hence, better operating conditions were created by the brachial plexus block.

In a similar study, comparing brachial plexus block through axillary approach using 5 ml ropivacaine 1% and 10 ml of saline (0.9% NaCl) and local anaesthesia using lidocaine 2%, the authors have reported considerable venous dilatation and 48.7% decline in pulsatility index (PI) with brachial plexus block when minimal alteration was noted in local anaesthesia group.

Immediate fistula patency was more than 90% in the current study. Even the primary patency at 3 months

| Parameter | n (%) |
|-----------|-------|
| Age group (years) |   |
| <51 | 13 (6.07) |
| 51-60 | 63 (29.44) |
| 61-70 | 97 (45.33) |
| 71-80 | 32 (14.95) |
| 81 and above | 9 (4.21) |
| Gender |   |
| Male | 132 (61.68) |
| Female | 82 (38.32) |
| Etiology |   |
| Diabetes mellitus | 57 (26.64) |
| Hypertension | 31 (14.49) |
| Interstitial nephritis | 30 (14.02) |
| Undetermined etiologies | 28 (13.08) |
| Multiple etiologies | 27 (12.62) |
| Glomerulonephritis | 24 (11.21) |
| drugs and toxins | 17 (7.94) |
| Site of AV fistula |   |
| Brachiocephalic | 133 (62.15) |
| Radiocephalic | 81 (37.85) |

**Table 1: Baseline characteristics and type of fistula in study population (n=214)**

| Parameter | Before | After | Mean change | P |
|-----------|--------|-------|-------------|---|
| Brachiocephalic blocks (n=133) |        |       |             |   |
| Brachial artery diameter (mm) | 2.98±0.18 | 3.07±0.27 | 0.09 | 0.002 |
| Cephalic vein diameter at elbow (mm) | 3.12±0.23 | 3.62±0.69 | 0.50 | <0.001 |
| Radiocephalic blocks (n=81) |        |       |             |   |
| Radial artery diameter (mm) | 2.07±0.19 | 2.15±0.27 | 0.08 | 0.031 |
| Cephalic vein diameter at wrist (mm) | 2.19±0.21 | 2.67±0.69 | 0.48 | <0.001 |
| Brachial artery blood flow (ml/min) | 29.97±12.36 | 43.5±26 | 13.53 | <0.001 |

SD – Standard deviation
was maintained by more than 80% of the subjects at both the elbow and wrist. Even though the functional patency was very high in the radiocephalic fistulas, but less than one-third of the brachiocephalic functional patency at 3 months. In a study that compared brachial plexus block through supraclavicular approach group [using 1:1 mixture of 0.5% L-bupivacaine and 1.5% lidocaine with epinephrine (1 in 200,000)] with local anaesthesia, 84% of the subjects in the brachial plexus block group showed graft patency at 3 months, but this proportion was only 62% in the local anaesthesia group.[6] The primary and functional patency rates reported in this study were comparable to the current study, along with the higher functional patency levels of radiocephalic fistulae were in line with current study findings. Another study comparing regional anaesthesia and general anaesthesia could not find any significant differences between both groups regarding early failure of AV fistula (14% in regional anaesthesia vs 11% in general anaesthesia, P = 0.80), and have specified regional anaesthesia have no major advantages over general anaesthesia in terms of fistula functioning. The early graft failure rates of the current study were comparatively higher than those reported by this study.[10] Primary patency levels reported by following regional block by few other studies were approximately 80% and were comparable with the current study findings.[11] Regional anaesthesia by supraclavicular or axillary approaches has been proved to have better vein diameter and postoperative graft patency compared to local anaesthesia or general anaesthesia by few other published studies on the subject.[3,12]

The key limitation of the current study was an absence of a comparison group which would have helped in documenting the relative superiority of the regional block compared to other alternative methods as well as to minimise and adjust for confounding. Even though the role of chance has been explicitly mentioned by P values, the role of potential bias in the estimation of outcomes cannot be completely ruled out due to an absence of blinding; the outcomes were measured as part of the hospital protocol.

There is a need to conduct large-scale, scientifically designed, randomised controlled trials to enhance the quality of available evidence on the subject. Till date, evidence-based guidelines are evolved based on systematic reviews and meta analyses on the subject, clinical decisions have to be made considering the efficacy, safety, and cost of different anaesthetic methods of choice, with due consideration to the expertise of the manpower and available facilities.

**CONCLUSION**

The current study findings prove that ultrasound-guided brachial plexus block results in good vasodilatation in the distal arm, and thereby create optimal operable conditions for AV fistula surgery. In about half of the subjects, the functional patency is maintained after 3 months. The functional patency is considerably better with brachiocephalic fistulas compared to radiocephalic fistulas.

**Financial support and sponsorship**
Nil.

**Conflicts of interest**
There are no conflicts of interest.

**REFERENCES**

1. Gold JA, Hoffman K. Fistula first: The national vascular access improvement initiative. WMJ 2006;105:71-3.
2. 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.
3. 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.
4. 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;21:730-3.
5. Robbin ML, Greene T, Cheung AK, Allon M, Bercoli SA, Kaufman JS, et al. Arteriovenous fistula development in the first 6 weeks after creation. Radiology 2016;279:620-9.
6. Aitken E, Jackson A, Kearns R, Steven M, Kinsella J, Clancy M, et al. Effect of regional versus local anaesthesia on outcome after arteriovenous fistula creation: A randomised controlled trial. Lancet 2016;388:1067-74.
7. Alsalti RA, el-Dawlatly AA, al-Salman M, Jommaa 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.

8. 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.

9. Lo Monte AI, Damiano G, Mularo A, Palumbo VD, Alessi R, Gioviale MC, et al. Comparison between local and regional anesthesia in arteriovenous fistula creation. J Vasc Access 2011;12:331-5.

10. Elsharawy MA, Al-Metwalli R. Does regional anesthesia influence early outcome of upper arm arteriovenous fistula? Saudi J Kidney Dis Transpl 2010;21:1048-52.

11. Reynolds TS, Kim KM, Dukkipati R, Nguyen TH, Julka I, Kakazu C, et al. Pre-operative regional block anesthesia enhances operative strategy for arteriovenous fistula creation. J Vasc Access 2011;12:336-40.

12. Shoshiashvili V, Tataradze A, Beglarishvili L, Managadze L, Chkhotua A. Influence of type of anesthesia on hemodynamic parameters and outcome of dialysis arteriovenous fistula operations. Georgian Med News 2015;249:20-7.