Anesthesia for Creation of a Forearm Fistula in Patients with Endstage Renal Failure

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The effects of local infiltration anesthesia, brachial plexus blockade, isoflurane, or halothane anesthesia on blood flow through the brachial artery and through a newly created forearm arteriovenous fistula (AVF) were compared in 36 patients with endstage renal failure. Brachial artery blood flow was measured at two different times, before anesthesia and during anesthesia but before surgery, using a pulsed Doppler flowmeter. AVF flows were calculated from brachial, radial, and ulnar blood flows at the end of surgery, 2 h after surgery, and 3 and 10 days after the procedure. Mean arterial pressure was lower in patients receiving isoflurane or halothane than in those receiving local anesthesia or brachial plexus blockade (BPB). There was a significant increase in brachial arterial blood flow following BPB (43.7 ± 13.7 to 196.9 ± 98.2 mL·min⁻¹) during isoflurane anesthesia (46.2 ± 13.9 to 153.1 ± 80.5 mL·min⁻¹) and during halothane anesthesia (49.9 ± 24.1 to 97.6 ± 62.1 mL·min⁻¹). During anesthesia, the difference in brachial artery blood flow between patients in the BPB and halothane groups was significant. Local anesthesia failed to increase brachial artery blood flow (44.8 ± 12.7 to 45.6 ± 11.3 mL·min⁻¹). In the immediate postoperative period, the AVF blood flow was lower in patients in the halothane group than in the other groups, but this difference was only significant when compared with BPB group. In the late postoperative period, AVF blood flows were lower in patients in the local anesthesia group than in the other groups. The authors conclude that the highest AVF blood flow with the least hemodynamic changes was obtained with the BPB technique. Nevertheless, the four types of anesthesia used in this study were suitable for this procedure, since no thrombotic complications occurred. (Key words: Anesthetics, volatile; halothane; isoflurane. Anesthetic techniques: brachial plexus blockade; infiltration. Measurement techniques: pulsed Doppler.)

HEMODIALYSIS VIA ARTERIOVENOUS FISTULA (AVF) is an established form of therapy for patients with endstage renal failure. Extracorporeal blood flow rates for efficient hemodialysis are above 200 mL·min⁻¹ and for reliable hemofiltration are above 400 mL·min⁻¹. Blood flow through the AVF less than 200 mL·min⁻¹ may result in thrombosis and limit the efficiency of hemodialysis. Thrombosis is the principal early and late complication of AVF, and may be prevented by maintaining a high blood flow in vessels during both the creation of AVF and the postoperative period. This may be influenced by the type of anesthesia.

Noninvasive and precise measurements of AVF blood flow may provide useful information for the management of AVF. The pulsed Doppler flowmeter used in this study provides a measurement of internal diameter of the AVF and mean blood velocity, allowing the calculation of blood flow in peripheral superficial arteries and in the fistula. The objective of this study was: 1) to compare four types of anesthesia (local LA, regional BPB, isoflurane ISO, or halothane HAL anesthesia) on blood flow of forearm arteries before the creation of AVF, and 2) to compare the AVF blood flow in these four groups of patients during the early postoperative period.

Materials and Methods

Thirty-six patients (23 men and 13 women) with endstage renal failure at the time of AVF creation were studied after obtaining their informed consent. The study was approved by the Pitié Hospital Human Research Ethics Committee. The mean age of the patients was 52 ± 16 yr (mean ± SD). All were in a stable condition with creatinine plasma concentrations of 8.5 ± 2.7 mg·dL⁻¹ and none had congestive heart failure at the time of the study. The hematocrit was less than 30% except in four patients with polycystic kidney disease.

Doppler flowmetry is based on the frequency change (ΔF) of an emitted ultrasonic wave after its backscattering by moving erythrocytes. The frequency change is a function of the emission frequency F, the mean velocity of red cells (V) and the angle θ between the ultrasonic beam and the direction of blood displacement:

\[ \Delta F / F = 2 \cdot V \cdot \cos \theta / C, \]

where C is the mean propagation velocity of ultrasound within tissues (1540 m/s). The range gated pulsed Doppler flowmeter (Echovar Alvar Electronic, Paris, France) we used has two main characteristics: an adjustable range gated system, and a double transducer probe, which considerably minimizes the error introduced by the angle between the ultrasonic beam and the axe of the vessel.

ADJUSTABLE RANGE GATED TIME SYSTEM

Both transducers are alternatively emitter and receiver. Short bursts (0.5 μs) of ultrasound (8 MHz frequency) are
emitted at a repetition rate of 32 KHz. Because an electronic gate is opened at an adjustable time after each emission burst, reflected signals are detected only while the gate is opened. The time elapsed between emission and reception and the duration of the gate opening respectively represent depth and thickness of the sample volume along the beam axis.\(^7\) With short gate duration (0.5 \(\mu s\) corresponding to 0.38 mm, vessel walls can be localized. This period can be gradually extended by increments of 0.5 \(\mu s\), so that the blood vessel wall is reached and then traversed. The first Doppler signals reflect the proximal vessel wall and the disappearance of the Doppler signals reflect the distal vessel wall. The diameter can then be computed. When the gate duration is adjusted so that the sample volume exactly encompasses the vessel diameter, the mean blood velocity can be registered. The blood flow rate is computed as follows:

\[
\dot{Q} = \pi \cdot V \cdot \frac{(D^2)}{4},
\]

where \(D\) is the internal diameter.

**Double Transducer Probe**

The probe is made of two transducers forming a fixed angle of 120°. The two probes are sequentially activated. In each experiment, the probe was chosen so that the two beams intersected in the middle of the investigated vessel. The same diameter and mean velocity must be obtained with the two probes (in absolute values). Thus, with the two probes, errors resulting from uncertainty of the value of angle \(\theta\) are avoided knowing that an error of 15° on the angle provides an error of 4% on the mean velocity.\(^8\) The Doppler flowmetry is reliable if a mean blood velocity less than 65 cm \(\cdot\) s\(^{-1}\) is measured.\(^9\)

Two hours before arriving in the operating room, all patients received im hydroxyzine (100 mg) or flunitrazepam (1 mg) along with their usual medications. The patients were randomly divided into three groups of nine subjects. Patients in the local anesthesia LA group (group 1) received an infiltration with 10 ml of 1% lidocaine without epinephrine. Patients in the BPB group (group 2) underwent supraclavicular brachial plexus blockade with 7 mg \(\cdot\) kg\(^{-1}\) of 1.5% lidocaine without epinephrine. Those receiving local anesthesia or BPB also received im flunitrazepam (0.35 \(\pm\) 0.30 mg). Patients in the ISO (group 3) and HAL (group 4) groups were anesthetized with isoflurane or halothane. In these last two groups, in order to facilitate induction and orotracheal intubation, 4 mg \(\cdot\) kg\(^{-1}\) thiopental and topical spray of 5% lidocaine were used. Increasing concentrations of isoflurane or halothane were inhaled by patients, and then orotracheal intubation was performed. Anesthesia was maintained with a 1.3 MAC concentration of the selected inhalation agent, along with 70% nitrous oxide in oxygen. Ventilation was controlled. Colloids (Plasmion\(^\circ\), Roger Bellon Laboratory) were administered (500 ml) when MAP decreased more than 20% from initial values.

The AVF was a side (artery) to end (vein) anastomosis between the radial artery and the cephalic vein in the forearm (26 patients) or the ulnar vein (five patients). In the five other patients, anastomosis was established using a biological graft (Veinograft) (SMAD\(^\circ\), Lab) (zero in LA, two in BPB, one in ISO, and two in HAL group). All AVFs were performed in the distal part of the forearm by the same surgeon. The duration of the intraoperative procedure was 55.8 \(\pm\) 17.5 min for all groups.

Fifteen minutes before the first measurements were obtained, the patients were placed in a supine position with their hand at the level of the heart. The brachial, ulnar, and radial artery blood flows were calculated from the diameter and mean blood velocity.

AVF blood flow can be evaluated in two ways. First, blood flow in the anastomosed vein can be measured. However, this measurement can be difficult in a new AVF. With a second method, AVF blood flow is calculated with brachial, radial, and ulnar blood flows. Classically, the hand is perfused, in an anterograde fraction, by the ulnar and radial arteries through the palmar arch. Doppler flowmetry allows the determination of the direction of blood displacement. The anastomosis between the radial artery and a vein for creation of AVF causes a decrease in resistance such that the radial blood flow becomes retrograde in the part of the artery closest to the palmar arch (fig. 1). AVF blood flow can be calculated as follows:

\[
\dot{Q}_{AVF} = \dot{Q}_{bra} - (\dot{Q}_{uln} + \dot{Q}_{rad})
\]

Physiologic data support the observation that hand blood flow is mainly cutaneous, while forearm blood flow is mainly through muscle.\(^9\) Hence, ulnar and radial arteries vascularize the cutaneous territory. The difference between these blood flows and the brachial artery blood flow represents the muscular blood flow.

Systolic and diastolic arterial blood pressures were measured by sphygmomanometry. Heart rate and ECG were monitored using a Hewlett Packard\(^\circ\) monitor. End-expiratory fraction of inhalation agents was measured with a Capnomac Datex analyzer (Datex\(^\circ\), Finland).

The forearm vascular resistance was calculated from Ohm’s law for resistances (\(Q = MAP/R\)), where MAP is the mean arterial pressure and \(Q\) the brachial artery blood flow. MAP was derived from the formula: MAP = (SAP - DAP)/3 + DAP, where SAP equals systolic arterial pressure and DAP is diastolic arterial pressure.

Brachial artery blood flow was noted before anesthesia and 10 min after local anesthesia (LA), 15 min after bra-

Fig. 1. Distribution of blood flows into fistula from ulnar and radial artery blood flows. Distal part of radial artery: A, antegrade blood flow; B, retrograde blood flow.

chial plexus blockade (BPB), and 20 min after induction of anesthesia with 1.3 MAC halothane or isoflurane.

AVF blood flow was recorded in each group at the following times: 1) immediately following surgery (PO1), 2) 2 h after the end of anesthesia (PO2), 3) 3 days (D3) after the creation of AVF, and 4) 10 days (D10) after the creation of AVF.

Intragroup comparisons were performed using analysis of variance and Student's t test for paired data whenever necessary. Intergroup comparisons were obtained by Student's t test for unpaired data. A probability of P < 0.05 was considered significant.

Results

Patient data are listed in Table 1. Despite the randomization, patients in the LA group were older than patients in the ISO group. Cardiac medications given chronically to these patients were similar in the four groups (Table 2). The etiology of the renal disease (chronic glomerulonephritis, chronic interstitial nephropathy, diabetic nephropathy, polycystic kidney disease, nephroangiosclerosis, unknown nephropathy) and the surgical technique (end to side anastomosis [n = 26], ulnar transposition [n = 5], biological graft [n = 5]) were similar in the four groups. All procedures were performed in the lower or middle part of the forearm.

Brachial artery blood flow (BABF) increased significantly after brachial plexus blockade and isoflurane and halothane anesthesia, as shown in Table 3 and in Figure 2. After brachial plexus blockade, BABF was significantly greater than after both local and halothane anesthesia, while it was not statistically different from the results obtained during isoflurane anesthesia. The increase in brachial artery blood flow in the BPB patients was due to both an increase in diameter (Table 4) and mean blood velocity. The muscular and cutaneous blood flows are shown in Table 5 before and after onset of anesthesia in the four groups.

The highest values of the mean blood velocity found in our subjects were about 55 cm·s⁻¹ during the postoperative period, which was within the limits of measurement by our flowmeter. The AVF blood flows, at each set of measurements selected in this study, are shown in Figure 3 and Table 6.

During the immediate postoperative period, AVF blood flow was not statistically different between the patients who received brachial plexus blockade, isoflurane, or local anesthesia. AVF blood flow was lower in patients receiving halothane anesthesia, but the difference was only significant compared with brachial plexus blockade. Thereafter, AVF blood flows remained lower in the patients who received local anesthesia, while no difference was observed between the three other groups. There was no correlation between AVF blood flow and patient age.

Mean arterial blood pressure (MAP) was lower during general anesthesia than during local anesthesia or brachial plexus blockade (Fig. 4) despite significantly greater in-

### Table 1. Main Characteristics of Patients in Each of the Four Groups (n = 9), Mean ± SD

<table>
<thead>
<tr>
<th></th>
<th>LA Group</th>
<th>BPB Group</th>
<th>ISO Group</th>
<th>HAL Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>59 ± 17*</td>
<td>51 ± 16</td>
<td>44 ± 16</td>
<td>53 ± 13</td>
</tr>
<tr>
<td>Creatinine</td>
<td>8.8 ± 4.1</td>
<td>8.3 ± 1.7</td>
<td>8.0 ± 2.8</td>
<td>9.0 ± 2.0</td>
</tr>
<tr>
<td>Hematocrit (%)</td>
<td>27 ± 5</td>
<td>26 ± 3</td>
<td>27 ± 3</td>
<td>28 ± 6</td>
</tr>
</tbody>
</table>

* P < 0.05 vs. group ISO.

### Table 2. Preoperative Antihypertensive Drugs and Cardiac Medications in the Four Groups (P = NS)

<table>
<thead>
<tr>
<th></th>
<th>LA Group</th>
<th>BPB Group</th>
<th>ISO Group</th>
<th>HAL Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drugs with central effects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium channel blocking drugs</td>
<td>5</td>
<td>3</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Beta-adrenergic blocking drugs</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Nitroglycerin</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

### Table 3. Brachial Artery Blood Flow in the Four Groups (n = 9)

<table>
<thead>
<tr>
<th></th>
<th>LA</th>
<th>BPB</th>
<th>ISO</th>
<th>HAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>44.0 ± 12.7</td>
<td>43.7 ± 18.7</td>
<td>46.2 ± 15.9</td>
<td>49.9 ± 24.1</td>
</tr>
<tr>
<td>A</td>
<td>45.6 ± 11.3</td>
<td>186.9 ± 98.2</td>
<td>156.1 ± 80.9</td>
<td>97.8 ± 62.1</td>
</tr>
</tbody>
</table>

* P < 0.05 vs. HAL.
† P < 0.05 vs. C, LA.
traoperative fluid administration (520.5 ± 70.5 ml in LA group, 527.8 ± 83.3 ml in BPB group, 1025.6 ± 335.3 ml in ISO group, 1055.6 ± 389.3 ml in HAL group; 

$P < 0.001$) in patients receiving halothane or isoflurane.

The changes in forearm resistances after anesthesia and creation of AVF are listed in table 7. The forearm resistances were greater during local anesthesia and remained greater after creation of AVF in the LA group. In patients in the HAL group, forearm resistances were less decreased after anesthesia than in the patients of BPB group. However, after creation of AVF, the decrease in forearm resistances was the same in patients in the BPB, ISO, and HAL groups at the 10th day.

**Table 4. Brachial Artery Diameter (mm) in the Four Groups before Anesthesia (Control = C), during anesthesia (A), and Postoperative Day 10 (D10)**

<table>
<thead>
<tr>
<th></th>
<th>LA</th>
<th>BPB</th>
<th>ISO</th>
<th>HAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>3.31 ± 0.48</td>
<td>3.19 ± 0.18</td>
<td>3.31 ± 0.27</td>
<td>3.31 ± 0.37</td>
</tr>
<tr>
<td>A</td>
<td>3.25 ± 0.51</td>
<td>3.48 ± 0.27*</td>
<td>3.40 ± 0.29</td>
<td>3.29 ± 0.33</td>
</tr>
<tr>
<td>D10</td>
<td>3.29 ± 0.42</td>
<td>3.55 ± 0.38*</td>
<td>3.57 ± 0.33*</td>
<td>3.33 ± 0.29</td>
</tr>
</tbody>
</table>

$P < 0.05$ vs. C.

All patients had normal postoperative courses. No pneumothorax due to supraclavicular plexus blockade was observed, and a chest x-ray was systematically performed. No patient exhibited thrombosis of an AVF during the first 3 months.

**Discussion**

The primary goals of an anesthetic for creation of a forearm fistula are to obtain a satisfactory vasodilatation of the vessels for the anastomosis, and to help in the prevention of thromboses. The present study shows that brachial plexus blockade and isoflurane anesthesia were as-

**Table 5. Values of Muscular (M) and Cutaneous (C) Blood Flows (ml min$^{-1}$) before and during Anesthesia in the Four Groups (n = 9), Mean ± SD**

<table>
<thead>
<tr>
<th></th>
<th>LA Group</th>
<th>BPB Group</th>
<th>ISO Group</th>
<th>HAL Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>M 26.9 ± 13.3</td>
<td>24.3 ± 11.6</td>
<td>30.6 ± 16.0</td>
<td>23.4 ± 14.7</td>
</tr>
<tr>
<td></td>
<td>C 17.1 ± 3.7</td>
<td>18.1 ± 8.6</td>
<td>15.7 ± 8.5</td>
<td>25.8 ± 23.3</td>
</tr>
<tr>
<td>Anesthesia</td>
<td>M 30.9 ± 11.6</td>
<td>90.9 ± 79.8*</td>
<td>57.6 ± 65.7</td>
<td>17.4 ± 21.1</td>
</tr>
<tr>
<td></td>
<td>C 14.7 ± 6.3</td>
<td>96.0 ± 42.8*</td>
<td>95.6 ± 34.2*</td>
<td>80.8 ± 49.0*</td>
</tr>
</tbody>
</table>

$P < 0.01$ vs. Control.

$P < 0.02$ vs. LA.

$P < 0.05$ vs. HAL.

**Fig. 2. Results of brachial artery blood flow (BABF) before (C = control) and under anesthesia (A), before surgery in the four groups (n = 9).$P < 0.05$ vs. HAL group; $P < 0.05$ vs. LA group.

**Fig. 3. AVF blood flow in the immediate postoperative period (end of surgery), 2 h after surgery (2h), and 3 and 10 days after creation of AVF (D3 and D10). $P < 0.05$ vs. HAL group; $P < 0.05$ vs. LA group.
associated with the highest peripheral blood flows during anesthesia as well as through the AVF during the entire postoperative period.

Blood flow was measured with a pulsed Doppler flowmeter as described by Safar.7 This method is a reliable technique, especially for comparative measurements in the same subject. The main limitation of this method is the estimation of vessel diameter. However, the magnitude of this error remains constant in the same subject when the measurements are performed by the same individual.8 In the present study, it was observed that the differences in arterial blood flow, between the creation of the AVF and its development during the early postoperative period, were due to the variations of mean blood velocity, and not to changes in the arterial diameters, except in the group receiving brachial plexus blockade.

No significant vasodilation was observed in our study after local anesthesia. Vascular uptake after local infiltration with 10 mL of 1% lidocaine is not likely to be responsible for any significant systemic effects.9 Although low concentrations of lidocaine given intradermally have been shown by Aps et al.10 to cause vasoconstriction in our study, no vasoactivity was detected. This technique was well accepted by most of our patients. Nevertheless, six complained of mild discomfort, especially when a biological graft was inserted, and sedative agents were administered after our flow measurements, at the beginning of the procedure.

Brachial plexus blockade (BPB) is commonly used for creation of AVF in patients with endstage renal failure.12 In the present study, suprachlavicular BPB was preferred to axillary BPB because, in our hands, it provides a better analgesia in the distribution of the musculocutaneous nerve.13 This analgesia is important especially for an ulnar vein transposition or when a biological graft is inserted. There were no complications with this technique. All nine patients had a normal postoperative chest x-ray. In the present study, lidocaine was preferred to bupivacaine, because of the potential toxicity of bupivacaine in the patients with endstage renal failure.14-16 Lidocaine without epinephrine was chosen because of the relatively short duration of the surgery and the limited effectiveness that epinephrine has in decreasing the plasma levels of short duration adrenaline local anesthetics.17

Our results show that BPB induced the greatest increase in brachial artery blood flows. This increase in blood flow was associated with an increase in muscular and cutaneous blood flows. These data are not in agreement with previous reports18 in which the methods used to evaluate the flows (plethysmography and isotopic methods) are less reliable than the pulsed Doppler.19

BPB causes regional sympathetic blockade, which leads to both arteriolar and venous dilation.18 The increase in artery blood flow under BPB results from both a vasodilation in large arteries as reflected by the increase in arterial diameter (P < 0.05) and a decrease in distal resistances as reflected by the increase in mean blood flow velocity.

The difference in changes following LA and BPB cannot be explained by differences in hemodynamic conditions, since arterial pressure remained unchanged after both BPB and LA, and fluid infusion was similar in the two groups.

Table 6. AVF Blood Flows (ml·min⁻¹) in the Early Postoperative Period in the Four Groups (n = 9) (Mean ± SD)

<table>
<thead>
<tr>
<th></th>
<th>LA</th>
<th>BPB</th>
<th>ISO</th>
<th>HAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>P01</td>
<td>209.8 ± 86.6</td>
<td>256.1 ± 74.3*</td>
<td>225.1 ± 77.7</td>
<td>174.9 ± 62.7</td>
</tr>
<tr>
<td>P02</td>
<td>247.9 ± 104.9</td>
<td>337.0 ± 80.7†</td>
<td>358.0 ± 122.7†</td>
<td>353.3 ± 102.7†</td>
</tr>
<tr>
<td>D3</td>
<td>307.8 ± 86.4</td>
<td>365.4 ± 67.7</td>
<td>418.9 ± 111.3†</td>
<td>374.4 ± 113.3</td>
</tr>
<tr>
<td>D10</td>
<td>929.4 ± 70.3</td>
<td>931.0 ± 111.4†</td>
<td>447.8 ± 89.3†</td>
<td>382.5 ± 105.4†</td>
</tr>
</tbody>
</table>

* P < 0.05 vs. HAL.
† P < 0.05 vs. LA.

Table 7. Forearm Resistances Expressed in dyne·cm⁻²·s in the Four Groups (n = 9), Mean ± SD

<table>
<thead>
<tr>
<th></th>
<th>LA Group (10⁴)</th>
<th>BPB Group (10⁴)</th>
<th>ISO Group (10⁴)</th>
<th>HAL Group (10⁴)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>23.0 ± 6.2</td>
<td>23.5 ± 11.3</td>
<td>20.5 ± 7.2</td>
<td>22.4 ± 13.7</td>
</tr>
<tr>
<td>Anesthesia D + 10</td>
<td>21.8 ± 6.2*</td>
<td>3.5 ± 1.5</td>
<td>6.6 ± 4.3</td>
<td>10.9 ± 7.5†</td>
</tr>
</tbody>
</table>

* P < 0.05 vs. other groups.
† P < 0.05 vs. BPB group.
In the immediate postoperative period, AVF blood flows were greater in patients in the BPB group than those in the HAL group. This was probably the result of a higher blood pressure and a greater vasodilatation in the BPB group. However, in the late postoperative period, AVF blood flows were identical in BPB, ISO, and HAL groups, and greater than those in the LA group.

During isoflurane and halothane anesthesia, increases in brachial artery blood flow were also observed. These increases were mainly due to an increase in cutaneous blood flow. In addition, in the present study, muscular blood flow increased twofold during isoflurane and remained unchanged during halothane, in spite of wide interpatient variations. Moreover, the increase in brachial artery blood flow was due to an increase in blood velocity and not to vessel diameter augmentation. This results from a distal effect of these agents on arteriolar and capillary blood flows, as reflected by the marked decrease in forearm and hand resistances. Vasodilatation during isoflurane and halothane has been shown to be multifactorial in origin. Both agents involve an endothelium derived relaxing factor (EDRF), which activates the production of cGMP in vascular smooth muscle and inhibits the contractile process and leads to relaxation. It seems that isoflurane does not interfere with the entry of calcium ions and, as opposed to halothane, extracellular calcium plays a major role during sustained release of EDRF. On the other hand, halothane interferes with alpha 2 adrenoceptor in vivo and in vitro.

In summary, BPB, ISO, and HAL anesthesia were associated with significantly higher brachial artery blood flows than was the LA technique. Blood flow through the AVF was still higher 10 days after the procedure. We conclude that, first, BPB offers some advantages in that it provides both excellent vasodilatation with few hemodynamic side effects. Second, in the postoperative period, although arteriovenous fistula blood flow is less in patients receiving LA than in those receiving BPB or general anesthesia blood flow was still sufficient for efficient hemodialysis. Third, intraoperatively, general anesthesia provides a significant decrease in mean arterial blood pressure. And, fourth, all anesthetic techniques employed in this study were satisfactory and no thrombotic complications were observed postoperatively in any of our patients.

References