Lower Extremity Bypass

Intraoperative Blood Flow Measurement

Ian Gordon, MD, PhD, Assistant Professor, Dept. of Surgery, Univ. of CA, Irvine

Surgical Approach

After completing a lower extremity arterial bypass, flow is measured before closure of the wound. Generally, we measure flow immediately after finishing the last anastomosis of the bypass and do not reverse heparinization.

A 4 or 6 mm flowprobe is employed for the saphenous vein, a 6 mm probe is employed for the popliteal artery, an 8 or 10 mm probe for the common femoral artery, and a 4 mm probe for tibial arteries.

Dacron grafts, which we very rarely use distal to the common femoral artery, allow direct measurement of flow by transit-time probes. Expanded PTFE grafts cannot be studied immediately by a probe placed on the graft, as air trapped in the graft interstices interferes with ultrasound transmission, and an accurate measurement is not possible until this gas is expelled.

Three methods, **A, B, C**, are used to measure flow. Method A is suitable for saphenous vein or dacron grafts; and Methods B and C are useful for PTFE grafts. We frequently employ Method C to measure the distribution of flow beyond the distal anastomosis in retrograde and antegrade directions. Method B is employed whenever exposure of the distal vessel receiving the bypass is poor, and placement of the probe on both sides of the distal anastomosis is difficult. Probes with back exiting cables are easier to use when exposure is poor.

Method A: Saphenous Vein or Dacron

To measure flow with saphenous vein or dacron, the probe is first placed just distal to the proximal anastomosis [position A]. Flow is documented on the flowmeter's built-in chart recorder. The presence of a hemodynamically significant stenosis causing turbulence is easily detected by a characteristic artifact in the flow vs. time waveform (Fig. 1). Similarly, the distal anastomosis is studied for turbulence by placing the flowprobe on the target vessel for the bypass just distal to the distal anastomosis [position B].

Assuming no technical problem requiring graft revision is present, we carry out our definitive flow measurement. The probe is placed on the bypass at any convenient position and flow is measured. We routinely measure flow with the graft temporarily clamped to confirm that accurate zero flow. The flow in the graft [F_{graft}] is then measured again. In order to measure resistance of flow through the graft and into the distal run-off vessels, we measure the pressure drop across the graft. A 26 gauge needle connected to a three-way stopcock and connected by plastic extension tubing to a sterile pressure transducer *(usually the anesthetist's radial artery catheter transducer)* is brought onto the surgical field. The bypass graft is punctured by the needle several cm distal to the proximal anastomosis. The mean pressure with the graft open [P_{open}] and with a clamp occluding the graft proximal to the needle [P_{clamp}] are recorded with the assistance of the anaesthetist. After finishing the measurements, the needle hole is closed with a 6-0 suture.

The resistance to flow, R, is calculated as:

$$R = F_{graft} / (P_{open} - P_{clamp})$$

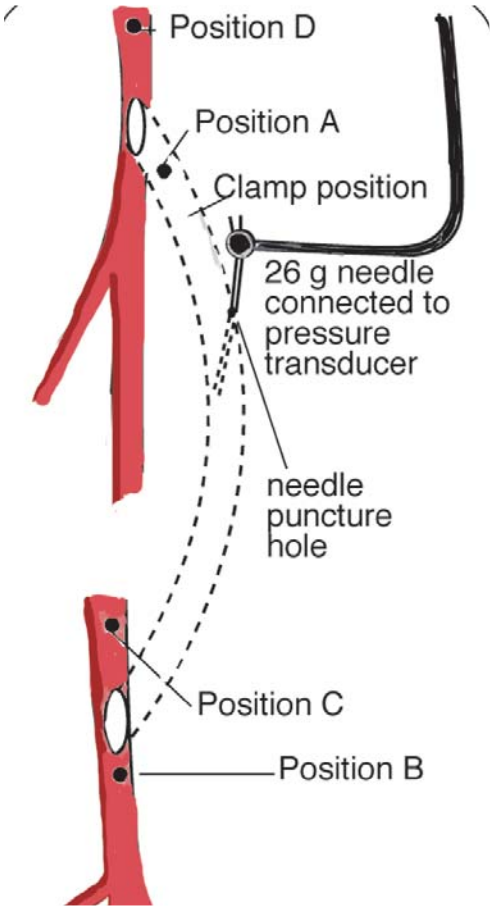


Fig. C8: Flow measurement sites during lower extremity bypass.

Lower Extremity Bypass

Intraoperative Blood Flow Measurement

Method B: PTFE Femoropopliteal Bypass

In a typical PTFE femoropopliteal bypass, the graft origin is from the common femoral artery. An 8 or 10 mm probe is placed on the common femoral artery just proximal to the bypass (Position D). Flow in the common femoral artery is then measured with the graft open [Fopen] or clamped [Fclamp]. Net graft flow is equal to (F_{open} - F_{clamp}). Resistance is measured as in Method A.

Method C

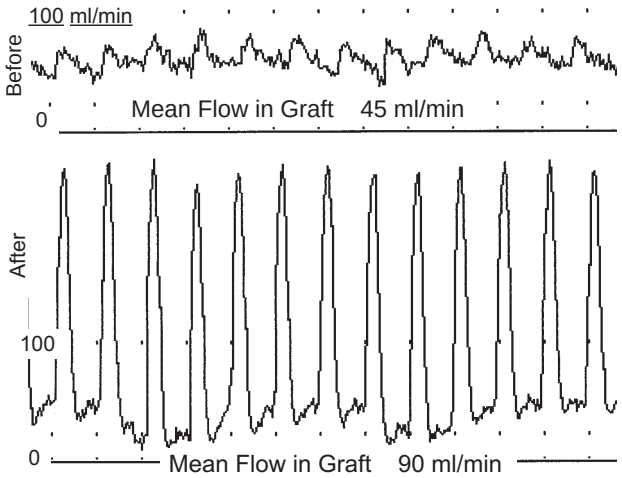
A 4 or 6 mm probe is placed on the target vessel just distal to the distal anastomosis [position B] and antegrade flow is measured with the bypass graft open [F_{ao}] and clamped [F_{ac}]. To measure retrograde flow, the probe is placed on the target vessel (Position C) just proximal to the distal anastomosis and flow is measured with the graft open [Fro] and clamped [F_{rc}]. Care need be taken to ensure that the direction of blood flow is carefully observed and negative and positive signs correctly employed to accurately measure flow. Net graft flow is calculated as (F_{ao} - F_{ac}) + (F_{ro} - F_{rc}). Again resistance is measured as in Method A.

Note: since pulse is a manifestation of pressure, not flow, an occluded graft may still have a distinct pulse. If two or more of the above criteria are met, it is generally felt that the graft is not acceptable and should be revised.

Acknowledgement

Ian Gordon, MD, PhD, Assistant Professor, Dept. of Surgery, Univ. of CA, Irvine

Waveform: Fig. 1



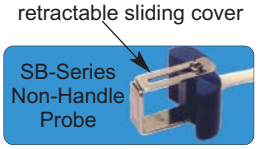
These waveforms show a case where a previously placed vein graft had a stenosis near the origin. The upper waveform shows the flow before correcting the stenosis. The lower waveform shows the flow pattern after correcting the stenosis.

Equipment Needed

300-Series Flowmeter

Flowprobes

Conduit	Recommended probe size
saphenous vein	4 or 6 mm
popliteal artery	6 mm
common femoral a.	8 or 10 mm
tibial artery	4 mm



Transonic Systems Inc.
Tel 800-353-3569 www.transonic.com Fax 607- 257-7256