Flow-Assisted Surgical Technique (F•A•S•T) during Vascular Access Surgery

Contents

To Measure Is to Know! ................................................................. 2
Intraoperative Blood Flow Assessment during Vascular Access Surgeries .................. 4
Intraoperative Blood Flow Measurement during Arteriovenous Fistula Creation .......... 5
Intraoperative Blood Flow Measurement during AV (Prosthetic) Graft Creation ........... 8
Flow Protocol: AV Fistula Banding .............................................................................. 10
Flow Case Report: Flow-guided Arteriovenous Fistula Artegraft® Banding ............... 12
Protocol: Flow-guided AV Fistula Surgical Revision .................................................. 13
References: Vascular Access ...................................................................................... 15
Introduction

To Measure Is To Know!

During surgery blood flow (or the lack thereof) impacts surgical success and long-term patient health. In order to assure the quality of surgery, and improve surgical outcomes, blood flow should be measured.

Surgeons Weigh In:

“As a surgeon you are continually striving to do the best possible operation tailored to the specific findings of a particular patient. You are trying to do the best with what you’ve got. Consequently, during surgery you are constantly re-assessing its progress to try to give the patient the best long-term result.

Any technology that you can use to provide an intraoperative assessment can be invaluable. Transonic Flow-QC intraoperative blood flow measurement is such a measurement. The measurements may either confirm what appears to be an acceptable surgical result, or it can alert you that there may be potential problems at a time when it can be more easily addressed. The assessment may dictate an immediate major revision or a change in the postoperative treatment such as the addition of long-term anticoagulation.

Transonic Flow-QC provides a measurable improvement in the quality of care you can extend to your patients. With Transonic Flow-QC you can: improve patient outcomes; reduce or delay the need for future interventions and document surgical results.”

T. Wolvos, MD, FACS

“The primary aim of intraoperative volume flow measurement is to obtain information on the immediate result of the reconstruction where a technical failure may jeopardize an otherwise successful operation.”


“Intraoperative assessment of graft patency is essential for detection of potentially reversible technical problems prior to leaving the operating room.”


“During banding of AVGs, it is very difficult to reduce access flow without causing a thrombosis. Therefore, one must measure flow to quantify the reduction.”

From presentation, “Banding (How I do it),” I. Davidson, MD, CIDA, 2011

“Flow reduction using intraoperative access flow monitoring is an effective and durable technique allowing for the correction of distal ischemia and cardiac insufficiency in patients with a high-flow autogenous access.”


“Accurate flow measurements can be of great assistance during vascular reconstructive surgery. The primary aim with these intraoperative measurements is to obtain information on the immediate result of the reconstruction, where a technical failure may jeopardize an otherwise successful operation.”


“Not a day goes by when this flowmeter doesn’t solve a problem for me.”

BP Mindich, MD

“Transit-time flow measurements are useful for surgical management during cerebrovascular surgery. The technique was simple to use and provided sensitive, stable, reliable results.”

**Introduction**

**To Measure Is To Know cont.**

“Why Measure Flow?” has many responses. One of the most powerful is, “If one makes the effort of sewing an anastomosis, one should also take the time to measure its flow.”

**Flow Measurement Provides An Objective Functional Assessment of Surgical Success**

In surgeries where restoration of flow is primary, flow must be measured. While the Technical Quality of Surgery can be readily observed at the end of surgery when the patient recovers from anesthesia, the Surgical Functional Success is often more difficult to determine. It requires intraoperative measurement of physiological measurements. Are all the grafts operational? Is organ flow adequate? Do these corroborate a surgeon’s clinical assessment? What is the patient’s long-term prognosis based on intraoperative clinical assessments, and what treatment regimen do these suggest?

**Informs Surgical Decisions**

Adequate pressure but a lower-than-expected flow often indicates a technical error such as a stitch that picks up the back wall of a vessel. Flow measurement can save the day for the surgeon and the patient in such instances.

**Heightened Need for Flow in More Challenging Procedures**

As surgical complexity increases, so has the need for intraoperative flow measurement for assessment and documentation. In procedures such as endoscopic surgery, the surgeon cannot palpate the vessel to get a qualitative assessment of technical adequacy of the surgical repair. As more and more patients are stented, a surgeon is now called upon to restore flow in the presence of failed surgical implants. Moreover, in surgeries such as partial liver transplant, flow and ratios between flows are critical to surgical success.

**Provides Peace of Mind**

Especially in cases where there is risk for severe functional complications such as intraoperative stroke, measurement and correction of factors that would result in such complications, provides a level of peace of mind to the surgeon.

**Continuous Quality Improvement (CQI)**

A basic tenet of any quality program is that you have to measure what you want to improve. If blood flow affects surgical success, it must be measured.

**Measurements Guide Post-op Care**

Intraoperative flow measurement of flow parameters may avoid the need for post-surgical tests, and provide information for further patient treatment during recovery and thereafter.

**Avoid Re-Operations**

Re-ops are costly, particularly when they are not reimbursed by the patient’s insurer. Whenever intraoperative flow measurement alerts the surgeon to a flow-limiting problem that can be corrected during surgery, re-operation is avoided and money is inevitably saved.

**Intraoperative Training Tool for Surgical Residents**

The use of intraoperative quality measurement devices such as flowmeters to confirm the quality of a surgical anastomosis has become an invaluable learning tool for residents and surgeons alike and has been integrated into numerous surgical training courses.

**Helps Develop Standards of Care**

New surgical protocols are developed using measurements, including blood flow measurements, and interpretation of all available physiological parameters.

**Proven Patient Care**

Exemplary patient care is the axiom. Hospitals must, therefore, stay on the forefront of medical innovation and quality assurance to attract the savvy patient who demands and deserves the best.

**Provides Strong Evidence**

In our litigious society, juries have become more inclined to grants large awards to patients. Surgical success, documented by intraoperative blood flow measurements, provides strong court evidence for the hospital or doctor in such instances.

**Flow Measurements Complement Pressure**

While an abnormal blood pressure may be tolerated by the body for prolonged periods, an abnormal blood flow can damage organs on short notice. Pressure divided by flow equals organ impedance, an important parameter for:

(a) Detection of technical error in an anastomosis;
(b) Selection of regimens for post-op patient treatment.

To Measure Is To Know!

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FAST-1-hb Vascular Access Rev B 2017
Intraoperative Blood Flow Assessment during Vascular Access Surgeries

“Use of the Transonic Flow-QC provides a measurable improvement in the quality of care you can extend to your patients. With Transonic Flow-QC you can: improve patient outcomes; reduce or delay the need for future interventions and document surgical results.”

T. Wolvos, MD, FACS

A vascular access is the dialysis patient’s lifeline. It is also considered the Achilles Heel of dialysis because they clot, get infected, thrombose and fail. Although dialysis access sites fail for many reasons, most of these are directly affected by the quality of flow through the access.

Intraoperative Flow Measurements Predict Fistula Maturation

During AV access creation, intraoperative blood flow measurements with a Transonic perivascular flowprobe provide quantitative volume flow values that instantly alert the surgeon to any flow-limiting problems that may jeopardize further maturation of the access. The first protocol for measuring flow through an AV access was developed by Drs. Anders Lundell and Nils H. Persson from the Dept. of Surgery, Malmö General Hospital in the early 1990s. They measured flow in the radial and ulnar arteries at the wrist to determine if there was sufficient flow to create a fistula. If flow was under 100 ml/min, they moved to the brachial artery to create a fistula.

Landmark Study

In 1998, Dr. Christopher Johnson, a transplant surgeon at the University of Wisconsin Medical School published a landmark study: Prognostic Value of Intraoperative Blood Flow Measurements in Vascular Access Surgery [1]. The paper’s conclusion was that intraoperative measurements of access blood flow provide objective, reliable data that correlate with outcome. Johnson’s study has been followed by others including key opinion leader Scott Berman from Tucson, AZ who went further to conclude that intraoperative blood flow measurements obtained at the time of autologous AVF construction can identify fistulas that are unlikely to mature; and therefore, require immediate revision or abandonment which will ultimately expedite the establishment of a useful access in the hemodialysis patient [4]. These and other studies provide indisputable evidence that Transonic intraoperative flow measurements with Transonic vascular handle flowprobes provide valuable information to the surgeon during fistula creation.

Fistula First Breakthrough Initiative Drives Measurements

The 2003 Fistula First Breakthrough Initiative sponsored by the Center for Medicaid and Medicare (CMS) in conjunction with the National Kidney Foundation (NKF) is determined to improve care for patients with chronic kidney disease by increasing AV fistula placement and use in suitable hemodialysis patients. Thus maturation of a viable AV access is the initial step in enabling successful long-term hemodialysis. Now over 60% of hemodialysis patients in the United States have a fistula placed. This has underscored the need for quantitative measurements during fistula creation to insure their maturation into a viable fistula.

Measurements during Revisions

Similarly, vascular surgeons tasked with saving or revising a vascular access have relied on intraoperative measurements to guide their banding or revision surgeries. Measuring arteriovenous access flow during revision surgery takes the guesswork out of knowing if the target flow has been reached.
Flow Protocol: Fistula Creation

Intraoperative Blood Flow Measurements during Arteriovenous Fistula Creation

Protocol courtesy of Jose Zamora, M.D. San Diego, CA

Introduction
The goals for measuring flow during fistula creation are:
1) To increase the probability of successful AV fistula maturation with quantitative blood flow measurements.
2) To ensure that the newly created fistula is not immediately robbing the lower arm of flow and setting the stage for ischemic "steal" syndrome (ISS).

Measurement Steps after AV Fistula Construction

1. Identify Vessel to Be Measured
   Identify and expose the AVF’s venous outflow. Identify and expose the arterial conduit distal to the AVF anastomosis.

2. Select Flowprobe Sizes (FMV or FTV-Series Flowprobes)
   Measure the vein and artery’s diameters with a gauge. Select a probe so that the vein will fill between 75% - 100% of the ultrasonic sensing window of the Flowprobe (Fig. 1).

3. Check Blood Pressure
   If systolic BP is greater than 100 mmHg, continue with measurement. If systolic BP is less 100 mmHg, low AV fistula flow may be caused by low BP. Wait until BP increases to more than 100 mmHg.

4. Apply Flowprobe to Vessel
   1. Select a site wide enough to accommodate the Probe’s acoustic reflector.
   2. Apply sterile gel to the Flowprobe to ensure good ultrasound coupling.
   3. Apply the Flowprobe to the vessel, bending the Flowprobe’s flexible neck so that the entire vessel lies within the sensing window of the probe and aligns at a 90° angle with the Flowprobe handle (Fig. 1).
   4. Check the Signal Quality Indicator on the AureFlo® or Flowmeter display to verify good acoustic contact.
   5. Listen to the pitch of FlowSound®. The higher the pitch, the greater the flow.

A. FISTULA MATURATION TEST

A1. Measure Venous Outflow
   End-to-End or Venous End-to-Arterial Side Anastomosis: When the AVF is constructed with an end-to-end or venous-end-to-arterial-side anastomosis, simply measure venous outflow distal to the venous anastomosis (Fig. 2).

Fig. 2: Measuring venous outflow flow in a fistula anastomosed end to side.

If the anastomosis is constructed with a venous-side-to-arterial-side anastomosis or end-artery-to-venous-side anastomosis, occlude the vein proximal to the venous anastomosis while measuring flow distal to the anastomosis (Fig. 3). If spasm occurs, papaverin can be locally infiltrated along the artery and vein while flow is continuously monitored.

Fig. 3: Measuring venous outflow flow in a fistula anastomosed side to side.

A2. Document Flows
   After applying a Flowprobe to a vein, wait ~ 10-15 seconds. When flow readings are stable, flow data can be captured by recording or taking a snapshot on the Aureflo®, or by pressing PRINT on a HT300-Series Flowmeter. If the HT300-Series flow reading is negative on the LED, press INVERT to reverse the polarity of the flow reading from negative to positive before printing out the waveform.

B. “STEAL” TEST

B1. Measure Fistula Arterial Flow
Measure brachial or radial arterial flow that supplies the fistula distal to the AV fistula anastomosis in order to detect imminent threat of ischemic “steal" syndrome (ISS) (Figs. 4-6).

Fig. 4: Artery filling 75-100% of Probe’s sensing window.

AV Anastomosis

Brachio-cephalic fistula

Flowprobe

Radial artery

Obstruction site

Cephalic vein

Ulnar artery

Fig. 5: Flow supplying the hand is measured with the Flowprobe placed on the artery distal to the AV Anastomosis.

B2. Evaluate Flow Values
Check that flow values are well above zero and that the direction of flow is running toward the hand (distally) and not reversed so that it is flowing (proximally) into the AV fistula. If in doubt, zero flow by occluding the artery immediately next to the flowprobe (Fig. 6).

No “Steal” Indication
If the blood flow running distally to the hand is well above zero, there is no imminent threat of "steal".

“Steal” Indication
If blood flow running to the hand is close to zero and/or flow is reversed and moving up the arm toward the AV fistula, the fistula may be banded. Flow is then remeasured in the arterial segment of the artery distal to AV anastomosis (Fig. 5). This step is repeated until the surgeon is satisfied that there is sufficient flow running distal from the AV fistula anastomosis to the hand and the threat of "steal" is not imminent.*


B3. Document Flows
After applying a Flowprobe to the artery, wait ~ 10-15 seconds for mean readings to stabilize. When flow readings are stable, flow data can be captured by recording or taking a snapshot on the Aureflo®, or by pressing PRINT on a HT300-Series Flowmeter. If the HT300-Series flow reading is negative on the LED, press INVERT to reverse the polarity of the flow reading from negative to positive before printing out the waveform.

Thresholds from the Literature

Thresholds (mL/min) to Predict AV Fistula Maturation: Comparison of Studies

<table>
<thead>
<tr>
<th>Summary of Results of Johnson Fistula Creation Study¹</th>
<th>AV-Fistulas</th>
<th>Flow (mL/min)</th>
<th>Failure within 90 days (Requiring Intervention)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radio-cephalic</td>
<td>&lt; 170</td>
<td>56 %</td>
<td></td>
<td>.001</td>
</tr>
<tr>
<td></td>
<td>&gt; 170</td>
<td>15 %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brachio-cephalic</td>
<td>&lt; 280</td>
<td>64 %</td>
<td></td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td>&gt; 280</td>
<td>18 %</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1: In radiocephalic fistulas, initial flows of less than 170 mL/min correlated with failure within 90 days. In brachiocephalic fistulas, that threshold was 280 mL/min.

Guidelines for Fistula Construction¹

<table>
<thead>
<tr>
<th>Flow Rate (mL/min)</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 100</td>
<td>Abandon site</td>
</tr>
<tr>
<td>100 - 300</td>
<td>At risk for early failure; observe closely; allow to mature &gt; 4-6 weeks before using</td>
</tr>
<tr>
<td>&gt; 300</td>
<td>Allow to mature 4-6 weeks before using</td>
</tr>
</tbody>
</table>

Table 2: AV Fistula guidelines as identified by Johnson study.¹

<table>
<thead>
<tr>
<th>Thresholds (mL/min) Predict Fistula Maturation: Four Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>AV Fistulas</td>
</tr>
<tr>
<td>Radio-cephalic</td>
</tr>
<tr>
<td>Brachio-cephalic</td>
</tr>
</tbody>
</table>

Table 3: Comparison of AV Fistulas threshold studies to predict maturation.

References:

1. Create AVF; Identify & expose:
   a. AV fistula venous outflow
   b. Distal arterial flow

2. Measure Vein Diameter; Select Flowprobe sizes.

3. Check systolic BP ≥ 100 mmHg
   If < 100 mmHg, wait until BP ≥ 100 mmHg

A. Fistula Maturation Test

   A1a. Measure venous outflow distal to anastomosis.
   A1b. Measure venous outflow distal to anastomosis while occluding vein proximal to anastomosis.

   A2. Evaluate Flow per pre-established thresholds
       Radiocephalic: >250-300 ml/min
       Brachiocephalic: > 400 ml/min
       Basilic vein transposition: > 500 ml/min

   A2a. Fistula likely to mature.
   A3. Examine anastomosis and site. Revise, if necessary.
   A4. Remeasure and evaluate Flow per pre-established thresholds.
   A5. Fistula maturity tenuous
       1. Alert dialysis staff to suspect fistula (Monitor fistulas with flows between 100-300 ml/min weekly).
       2. Revise 2).
       3. Seek another fistula site 1).

B. Steal Test

   B1. Measure arterial flow distal to anastomosis while occluding vein proximal to anastomosis to detect imminent steal.

   B2. Evaluate flow values. Check that flow runs distally and is > zero. (Clamp to zero, if in doubt.)

   B2a. Steal not indicated.
   B3. Steal possible; band fistula & remeasure distal arterial flow.
   B4. Repeat steps above until distal arterial flow indicates that steal is not imminent.
Flow Protocol: Prosthetic Graft Creation

Introduction
Flow cannot be measured directly on newly inserted prosthetic ePTFE grafts (Fig. 1) because air within the synthetic graft walls attenuates ultrasound signal transmission. Graft outflow is therefore measured on the outflow vein following completion of both the arterial and venous anastomoses (Figs. 2, 3). If the distal vein has not been ligated, flow is still measured proximal to the anastomosis, while the distal unligated section of the vein is temporarily occluded (Fig. 4).

Measurement Steps:

1. Identify Vessels to Be Measured
Identify the exposed segments of the venous outflow conduit for the graft. Determine the optimum site (wide enough to accommodate the Probe’s acoustic reflector) for applying the Probe, and clean the vein at this site from fat and excess tissue.

2. Select Flowprobe Sizes
Estimate the diameter of the outflow vein with a gauge. Select a Probe size so that the vein will fill between 75% - 100% of the lumen of the Probe.

3. Apply Flowprobe
Apply sterile Aquasonic® Gel 100 to the Flowprobe to provide ultrasound coupling between the Probe body and Probe reflector. Apply the Flowprobe to the vein, proximal to the anastomosis, bend the Probe’s flexible neck segment as necessary, so that the entire vein lies within the lumen of the Probe and aligns with the Probe body (Fig. 5). Listen to the pitch of FlowSound® as the Flowprobe is applied to the vein. The higher the pitch, the greater the flow.

Check the Signal Quality Indicator (bucket display) on the Flowmeter’s front panel or AureFlo’s green bars for ultrasound acoustic contact. An acoustic error message will be displayed if ultrasound contact falls below an acceptable minimum.

4. Measure and Evaluate Venous Outflow
With the Flowprobe positioned as under Step 3 (above), measure venous average flow as displayed on the Flowmeter. An initial venous outflow < 400 mL/min is associated with a higher rate of initial graft failure. As the site recovers from surgery, flow will increase to levels preferred for hemodialysis (> 600 mL/min).

References

Table 1: In prosthetic grafts, initial flows of less than 400 mL/min foreshadowed failure within 90 days.

<table>
<thead>
<tr>
<th>Graft Type</th>
<th>Flow (mL/min)</th>
<th>Failure within 90 Days (Requiring Intervention)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTFE Grafts</td>
<td>&lt; 400</td>
<td>65%</td>
<td>&lt; .01</td>
</tr>
<tr>
<td></td>
<td>&gt; 400</td>
<td>40%</td>
<td></td>
</tr>
</tbody>
</table>

Table: Graft Type Flow Rate Recommendation

- ≤ 250 mL/min: Abandon site immediately
- 250 - 400 mL/min: Consider prophylactic anti-coagulation

5. Document Flows
   After applying a Flowprobe to a vein, wait ~ 10-15 seconds. When flow readings are stable, flow data can be captured by recording or taking a snapshot on the Aureflo®, or by pressing PRINT on a HT300-Series Flowmeter. If the HT300-Series flow reading is negative on the LED, press INVERT to reverse the polarity of the flow reading from negative to positive before printing out the waveform.

6. Measure Potential for Steal Syndrome (OPTIONAL)
   With the Flowprobe placed on the vein as previously, measure flow with, and without, occlusion of the artery distal to the arterial anastomosis. The difference between the two readings equals flow in the distal branch of the artery. When the flow reading without distal occlusion is higher than the reading with occlusion, blood in the distal branch is flowing retrograde to augment fistula flow and vascular steal may develop. (Note: Alternately, distal arterial flow can be measured directly by placing a Flowprobe on a properly cleaned arterial site distal to the anastomosis.)

Flow Measurement Protocol

1. Construct AV Graft:
   Identify & expose venous outflow.

2. Measure Outflow Vein Diameter;
   Select Flowprobe size.

3. Measure Blood Pressure

   Systolic BP > 100 mmHg
   - 4a. Apply Flowprobe
   - 5a. Measure venous outflow distal to anastomosis

   Systolic BP < 100 mmHg
   - 4b. Wait until systolic BP > 100 mmHg

   End-to-end or venous end-to-arterial side anastomosis.

   Side-to-side or arterial end-to-venous side anastomosis.

5a. Measure outflow distal to anastomosis while occluding vein proximal to anastomosis

6. Evaluate Flow per pre-established thresholds

   Flow does not meet pre-established threshold
   - 7b. Examine anastomosis and site.
   - 8. Remeasure and Evaluate Flow per pre-established thresholds

   Flow meets threshold
   - 7a. AV Graft likely to be able to be used

9. AV Prosthetic Graft use tenuous.
   Abandon, construct another graft.
Flow Protocol: Fistula Revision

Flow-guided AV Fistula Banding

Courtesy of M. R. Scheltinga, M.D., Máxima Medical Center, Veldhoven, The Netherlands.

Why Band a High Flow Fistula?
The need to increase venous outflow resistance in an arteriovenous fistula (AVF) used to deliver hemodialysis results from:

Hemodialysis Access-Induced Distal Ischemia (HAIDI)
Clinically significant HAIDI, that occurs primarily in diabetic patients, is a potentially devastating complication of an AVF. The surgeon’s challenge is to relieve the distal ischemia, but maintain a functional AVF for hemodialysis. One strategy is to band the AVF to increase AVF flow resistance, thereby reducing AVF flow and increasing distal flow.

Cardiac Overload
When AVF flow is too high (~>2L/min), cardiac function can become compromised resulting in cardiomegaly. Banding increases AVF resistance and lowers fistula flow, thereby reducing excessive stress on the heart.

Flow-Guided Fistula Banding
The surgeon begins with a pre-operative AVF flow level (determined by a Transonic® Hemodialysis Monitor in the dialysis clinic) and pre-sets the percent decrease in AVF flow to be achieved by banding. As the band is tightened, AVF venous outflow is measured intraoperatively. These continuous measurements guide the surgeon in achieving a target AVF flow value.

Flow Measurement Steps

Preoperative: From preoperative surveillance in the hemodialysis clinic, determine % drop in flow to be achieved by banding.

1. Identify /Expose Fistula Venous Outflow
Make a second 1.5-cm incision at least 10 cm downstream (of the upper arm cephalic or basilic vein) towards the axilla away from the dialysis cannulation sites. Identify and expose the AVF venous outflow. Check if this part of the vein is suitable for measurements (no scar tissue/aneurysms/adhesions).

2. Select Flowprobe Size (FTV-Series)
Measure the vein’s diameter. Select a probe so that the vein will fill between 75% - 100% of the flowsensing window of the probe (Fig. 1).

3. Measure Fistula Venous Outflow
   a) Confirm that the outflow site is wide enough to accommodate the Flowprobe’s acoustic reflector.
   b) Apply sterile gel inside the Flowprobe’s sensing window to ensure good ultrasound coupling.

4. Document Flows
   c) Apply the Flowprobe to the vein, bending the probe’s flexible neck so that the entire vein lies within the Probe’s sensing window (Fig. 1).
   d) Check the Signal Quality Indicator on the AureFlo® or Flowmeter display to verify good acoustic contact.
   e) Listen to the pitch of FlowSound®. The higher the pitch, the greater the flow.

5. Document Flows

   a) Confirm that the outflow site is wide enough to accommodate the Flowprobe’s acoustic reflector.
   b) Apply sterile gel inside the Flowprobe’s sensing window to ensure good ultrasound coupling.

Flow Measurement Protocol

0. Pre-operative: Determine % fistula flow decrease to be achieved by banding.

1. Expose AV fistula and its venous outflow (2 incisions).

2. Expose venous outflow diameter and select Flowprobe size.

3. Apply Flowprobe to venous outflow site.

4. Measure baseline flow. Calculate target flow (baseline flow times % decrease).

5. Tighten band. Remeasure flow.

6. Repeat step 5 until flow reaches intraoperative target flow.

Fig. 1: Align the probe on the vessel as shown.

Flow-guided AV Fistula Banding cont.

Figs. 1, 2: HAIDI: Banding of an AV fistula (AVF) may be indicated for hemodialysis access induced distal ischemia (HAIDI). Preoperative angiography of HAIDI patient with radiocephalic AVF shows the absence of hand arteries visualization (Fig. 1). Tissue necrosis in the hand (Fig. 2) also indicates presence of HAIDI.

Fig. 3: Banding: Minimally invasive positioning of a Transonic volumetric flowprobe guides the degree of tightening of a 5 mm Dacron band during this procedure.

Fig. 4: A 5 mm Dacron band is fixed using a clip and stitches. In this patient, AVF thrill was maintained and radial arterial pulses returned.

Fig. 5: Banding may also be performed for a high flow AV fistula (HFA) > 2L/min. This patient suffered from fatigue in the presence of a 3.7 L/min upper arm AVF.

Fig. 6: If HFA is also associated with HAIDI, measurement of finger pressures is also required. Once an optimal combination of access flow (> access thrombotic threshold level, generally > 500 mL/min) and finger pressure (>50 mmHg) is attained, the band is fixed.

REFERENCES:
www.vascularprocedures.com/html/algemeen/home.php

Flow Case Report: Fistula Revision

Flow-Guided Fistula Artegraft® Banding

Zamora JU II, MD, Balboa Transplant Institute, San Diego, CA

Introduction

Clinically significant steal syndrome is a potentially devastating complication of an arteriovenous (AV) fistula or graft and is often characterized by negative (reversed) flow in the distal artery. The challenge for the surgeon is to relieve the distal ischemia, but maintain a functional AV access with sufficient flow to deliver dialysis. One strategy is to band the access to increase flow resistance, thereby reducing access flow and increasing distal arterial flow.

Traditional banding methods modify the arterial or venous ends of a graft. This can compromise both the efficacy of hemodialysis and/or the life of the AV access. The Zamora Method™ is a novel banding procedure that uses hemoclips on collagen AV Artegrafts® and intraoperative flow measurements with Transonic perivascular Flowprobes to guide the banding procedure. One advantage of the Zamora banding procedure is that the hemoclips can be adjusted and/or removed during angioplasty. Traditional banding methods do not lend themselves to modification or reversal without surgical intervention.

Method

Pre-operative AV access flow is measured during dialysis with a Transonic Hemodialysis Monitor. The surgeon then determines the percent decrease in access flow to be achieved by the banding procedure. Medium hemoclips are then placed on the midsegment of an Artegraft® (Fig. C).

Artegraft flow is decreased by the depth of the hemoclip position on the graft and the distance between the clips. The clips are generally placed 10 mm apart (range: 8 - 20 mm) depending on the “length” of band desired. The angle of placement varies from 30 to 90 degrees varying the “depth” into the graft needed. A medium hemoclip placed at 90 degrees occludes to a 3.5 - 3.7 mm opening. As the clips are applied, Artegraft® flow is measured at the venous end of the graft with a 6 mm Transonic Flowprobe (Fig. D).
Flow Case Report: Fistula Revision cont.

Flow-Guided Fistula Artegraft® Banding cont.

Results

This method was utilized in over 250 patients over the past eight years with excellent results in both graft patency and correction of Steal Syndrome. The method maintains both a “maximal” inflow and outflow of the Artegraft® at the time of hemodialysis. Optimally, the arterial (inflow) needle is placed on the arterial ½ of the graft, and the venous (outflow) needle is placed on the venous ½ of the graft (Fig. E). During dialysis, the flows both into and out of the dialysis machine are maximized. Clips (banding) can be “reversed/removed” with an angioplasty balloon at the time of the first graft thrombectomy, if necessary. Often in older, diabetic patients with peripheral artery disease, banding reversal will not be tolerated. Steal syndrome returns, and a more permanent banding method can still be utilized to maintain optimal, long-term, lower Artegraft® flow.

Conclusion

Transonic Flowprobes provide on-the-spot measurements of volume flow within an Artegraft® as the graft is banded to treat steal syndrome.

Reference

Flow Protocol: Fistula Revision

Flow-Guided Fistula Surgical Revision

Fistula banding to relieve Dialysis Access-Induced Steal Syndrome (DASS) can be counter-productive. Therefore, alternative methods to reduce flow through an high access bypass have been developed. They include the following:

**Distal Revascularization-Interval Ligation (DRIL)**

DRIL eliminates a potential pathway for steal syndrome by ligating the artery distal to the origin of the AV fistula, and revascularizing the extremity through creation of a bypass (saphenous vein, bovine or PTFE graft) from above the AV fistula to below the AV fistula.

**Revision Using Distal Inflow (RUDI)**

RUDI technique calls for ligation of the fistula at a site slightly proximal to the fistula’s origin and then re-establishes flow via a bypass from a more distal arterial source to the venous limb of the fistula.

**Proximalization of Arterial Inflow (PAI)**

PAI converts the arterial supply of the arteriovenous access to a more proximal artery with higher capacity by using a small-caliber polytetrafluoroethylene (PTFe) graft as a feeder.

**Flow Measurement Protocol**

1. Expose arterial segment of fistula for pre-bypass flow.
2. Select Flowprobe Size: the vessel diameter should fill 75 - 100% of the Probe’s sensing window.
3. Apply Flowprobe as shown in Fig. 1 using sterile Aquasonic Gel 100 between the probe body and probe reflector to provide ultrasound coupling. Check the Signal Quality Indicator on the Flowmeter’s front panel or the AureFlo® display to ensure good acoustic contact.
4. Measure Baseline Flow. Listen to the pitch of FlowSound® as the Probe is applied to the vessel. The higher the pitch, the higher the flow.
5. Note: if flow is traveling antegrade or retrograde. Retrograde flow indicates the presence of DASS.
6. Construct the Bypass.
7. Measure and evaluate bypass outflow.
References: Vascular Access Surgery

THEORY

ACCESS CREATION

ACCESS REVISION

ACCESS REVISION


