Don't You Want To Know the Flow in Your Micro-vessels?

- Quantify restored flow in the smallest vessels
- Improve reattachment and flap flow rates
- Measure flow quickly and easily

Microvascular Lit Pack (CV-100-Lit) Rev D 2023

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Microsurgical Flowprobes take the guesswork out of knowing volume flow.

Transonic® Microsurgical Flowprobes work with Transonic® Flowmeters to measure volume flow in 0.5 - 3.8 mm blood vessels and grafts. The non-constrictive Flowprobes use gold standard transit time ultrasound technology to measure volume blood flow directly within these small blood vessels.

The new line of microvascular Flowprobes now offer the surgeon a quantitative tool with which they can objectively assess the quality of the reconstruction or replantation. Unseen blood flow obstructions can be detected intraoperatively and repaired before leaving the operating room.

No longer will a micro-vascular surgeon have to rely solely on clinical impressions to assess the quality of the surgery during the procedure. This on-the-spot volume flow technology produces flow information quickly, accurately, and non-intrusively. The ability to immediately correct otherwise undetectable flow restrictions provides the surgeon with a unique opportunity to improve their patients' outcomes.

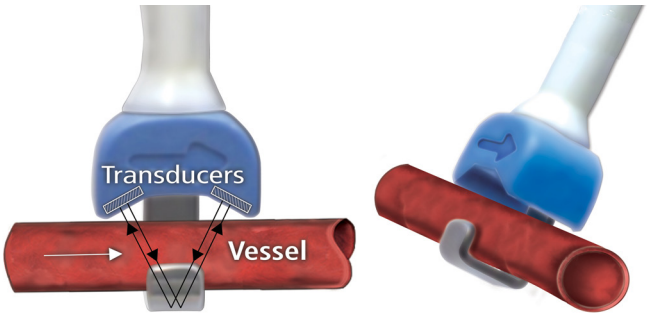
"...TTFV (Transit-time Flow Volume) provides novel physiologic flap data and identifies flow anastomoses and higher-flow venae comitantes. These data have clinical value in microsurgery and hold the potential to reduce microvascular complications and improve outcomes."
JC Selber, MD, MPH et al

"The TTUT measurements consistently correlated with the surgeon's observations in all 28 lymphatic vessels — healthy-appearing lymphatic vessels demonstrated flow values higher than those from unhealthy-appearing lymphatic vessels. ...Based on the above findings, we concluded that TTUT holds promise in 1) guiding the lymphatic vessel selection, 2) confirming anastomotic patency, and that 3) the absence of "wash out" may not unequivocally indicate anastomotic occlusion."
WF Chen, MD et al

"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."
A Lundell, MD, FACS

TRANSIT-TIME ULTRASOUND TECHNOLOGY

MEASURES VOLUME FLOW, NOT VELOCITY



Two transducers pass ultrasonic signals, alternately intersecting the vessel in upstream and downstream directions. The difference between the two transit times yields a measure of volume flow.

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Transonic Systems Inc. is a global manufacturer of innovative biomedical flow measurement equipment. Founded in 1983, Transonic sells state-of-the-art, transit-time ultrasound devices for surgical, hemodialysis, perfusion, ECMO, and medical device testing applications, and for incorporation into leading edge medical devices.

USA/Canada
Transonic Systems Inc.
Tel: +1 607-257-5300
Fax: +1 607-257-7256
support@transonic.com

Europe
Transonic Europe B.V.
Tel: +31 43-407-7200
Fax: +31 43-407-7201
europe@transonic.com

Asia/Pacific
Transonic Asia Inc.
Tel: +886 3399-5806
Fax: +886 3399-5805
support@transonicasia.com

Japan
Nipro-Transonic Japan Inc.
Tel: +81 04-2946-8541
Fax: +81 04-2946-8542
japan@transonic.com

Flow-assisted Surgical Techniques & Notes* Reconstructive Microsurgery Protocol

*Flow-Assisted Surgical Techniques ("F•A•S•T") and Protocols are drawn from surgical experiences by transit-time flow measurement users and passed along by Transonic for educational purposes. They are not intended to be used as sole basis for diagnosis. Clinical interpretation of each patient's individual case is required.

Introduction

During reconstruction or replantation microsurgery, a surgeon may elect to use a Microsurgical Flowprobe as a quantitative intraoperative tool to detect unseen blood flow obstructions which could thus be repaired before leaving the operating room.[3]

Measuring Blood Flow[1,2]

1. Identify Vessels to be measured

Expose and identify arterial inflow and venous outflow vessels to be used in the reconstruction.

2. Select Flowprobe Size

Measure the vessel diameter of the vessels to be measured with a gauge before opening the Flowprobe package. Select a Flowprobe size so that the vessel will fill between 75% - 100% of the Probe's ultrasonic sensing window.

3. Prepare Vessel for Flowprobe

Select a site wide enough to accommodate the Flowprobe's acoustic reflector. Clear approximately 1 cm of the vessel of fascia or fat for an accurate measurement. Fat could interfere with acoustic transmission.

4. Add Couplant to Flowprobe

Fill the window of the Flowprobe with ultrasonic gel or submerge the Flowprobe's head in saline in the surgical field.

5. Apply Flowprobe

Apply the Flowprobe at right angles to the vessel (Fig. 1) taking care not to "twist" or "lift" the vessel with the Flowprobe. Apply the Flowprobe so that the entire vessel lies within the ultrasonic sensing window of the Probe.

6. Check Signal Strength

Check the Flowprobe's ultrasonic signal strength on the Monitor display or Flowmeter front panel.

7. Measure Multi-stage Flow(s) as needed[4]

8. Document Flows for Case Record[1,2]

When the waveform appears stable (10-15 seconds) record flow, take a snapshot of the measurement or print the waveform to document flow values. If the Flowmeter displays a negative flow, press the INVERT button to change the polarity before printing the waveform. Leave the probe on the vessel until the printing stops or a snapshot or recording has been captured (8 – 10 seconds).

References:
1 Measuring PeriFlowprobe(CV-180-mn)RevA2018USltr
2 AU-QRG-Optima-EN Rev E
3 Selber JC *et al*,"A Prospective Study of Transit Time Flow Volume (TTFV) Measurement for Intra-operative Evaluation and Optimization of Free Flaps," Plast Reconstr Surg. 2013; 131(2): 270-81.
4 Della Puppa A *et al*, "Intraoperative Flow Measurement by Microflow Probe During Surgery for Brain Arteriovenous Malformations," Neurosurg 2015; Jun;11 Suppl 2:268-73.

Flow Measurement[1,2,4]

Select Correct Flowprobe Size

↓

Measure Baseline Flows
on arterial inflow and venous outflow vessels

↓

Determine surgical strategy for flap reconstruction

Measure flows immediately after anastomosis and reperfusion

↓

Record flow values of arterial inflows and venous outflows

↓ **Flow equal or more than baseline**

Evaluate surgical strategy vis á vis flow values[4]

Measure flows 30 minutes after anastomosis and reperfusion

↓

Compare to other flows and determine surgical strategy

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Publication Brief

A Prospective Study of Transit Time Flow Volume (TTFV) Measurement for Intraoperative Evaluation and Optimization of Free Flaps.

Selber JC *et al,* University of Texas MD Anderson Cancer Center — 2013

OBJECTIVE

To determine if transit-time volume flow measurements would improve decision-making in microvascular free tissue transfer procedures.

STUDY

Transit-time volume flow was measured in 52 consecutive free flaps (five types) by five surgeons. Thirty-eight (73.1%) of the flaps were harvested to reconstruct head and neck defects, while the remaining 14 (26.9%) (all TRAMs) were harvested for breast reconstruction. Flow measurements were performed:

- *In Situ*, after flap elevation and isolation on its pedicle;
- Immediately following anastomosis and reperfusion;
- Thirty minutes following anastomosis and reperfusion.

Intraoperative decisions based on transit-time volume flow measurements were documented.

RESULTS

- Arterial inflow was, on average, 1.5 times greater than venous outflow, and arterial resistance was 3.59 times greater than venous resistance (arterial: 9.04 mL/min; venous: 7.24 mL/min)
- Free transverse rectus abdominis musculocutaneous (TRAM) flaps had the highest arterial and venous flows (14.2 mL/min; venous: 11.3 mL/min), and free radial forearm flaps (RFF) had the lowest (arterial: 6.33 mL/min; venus 5.29 mL/min).
- Compared to the baseline (*In Situ*) measurement, all flaps had higher flows immediately after transfer (Time 1) ($p<0.0001$), but no significant differences were seen 30 minutes later (Time 2) ($p=0.68$). Arterial resistance, however, increased during that interval ($p=0.006$).
- In more than a third of the cases (19 out of 52), operative decisions on when to revise an anastomosis, were modified on the basis of transit-time volume flow findings.

CONCLUSION

"Transit-time volume flow measurements provide novel physiologic flap data and identify flawed anastomoses and higher-flow venae comitantes. These data have clinical value in microsurgery and hold the potential to reduce microvascular complications and improve outcomes."

TAKE HOME POINTS

- This publication from a microvascular surgeon key opinion leader provides evidence that volume flow measurements can provide quantifiable measurements of one of the most critical pieces of microvascular reconstruction: inflow and outflow.
- The author notes that perhaps the most compelling finding of the study is that flow measurements could alter or augment surgical decision making as it had in 36% of the cases in the study. These quantitative measurements "fill a knowledge gap" in microsurgery.

REFERENCE:

Selber JC, Garvey PB, Clemens MW, Chang EI, Zhang H, Hanasono MM,"A Prospective Study of Transit Time Flow Volume (TTFV) Measurement for Intraoperative Evaluation and Optimization of Free Flaps," Plast Reconstr Surg. 2013; 131(2): 270-81. (Transonic Reference # 9762AHM)

Publication Brief

Refining Perforator Selection for DIEP Breast Reconstruction Using Transit-time Flow Volume Measurements

OBJECTIVE

To examine the usefulness of transit-time ultrasound volume flow measurements in assessing perforator vessels in deep inferior epigastric artery perforator (DIEP) flap harvesting and to evaluate their correlation with computed tomographic angiography (CTA) and hand-held Doppler signals in identifying perforators.

STUDY

- CTA was used to identify abdominal wall perforators for ten consecutive free DIEP breast reconstructions in eight women (two with bilateral mastectomies, six with unilateral).
- Abdominal wall perforating vessels >1 mm in diameter were evaluated intraoperatively with a conventional hand-held 8-MHz Doppler and a transit-time ultrasound flowmeter.
- The location of the vessels was correlated with preoperative CTA.
- Information about arterial versus venous flow patterns and mean flow values were recorded for each vessel typically, with a 2 mm Flowprobe, but occasionally, with a 3 mm Flowprobe. Flow values were correlated with both CTA and hand-held Doppler signals.
- Information about arterial versus venous flow patterns and mean flow values were recorded for each perforator.
- Perforators with high volume flows and an arterial waveform were selected to supply the flap.

RESULTS

- Of the 54 eligible perforators identified, transit-time flow measurements showed arterial flow waveforms in 15 of 16 perforators identified by CTA and in 2 of the remaining 38 vessels.
- Mean flow for the 16 arterial vessels was 5.3 mL/min. Mean flows for the remaining 38 dissected vessels was 2.1 mL/min.
- Transit-time flow measurement sensitivity in identifying arterial perforators was 94%; specificity was 95%.
- Hand-held Doppler was misleading in 70% of vessels.

CONCLUSION

- Transit-time flow measurements distinguished arterial from venous waveforms in vessels that appear arterial by hand-held Doppler signals.
- CTA and transit-time flow measurements had high correlation.
- The use of transit-time flow measurements may prevent poor perfusion seen in some DIEP flaps.

DISCUSSION

This group from the University of Toronto tested the use of transit-time ultrasound flowmetry to identify optimal deep inferior epigastric arterial perforators to harvest for breast reconstruction. Moreover, they suggest that transit-time flowmetry may be able to predict early patency in completed microvascular anastomoses, as is the case in CABG surgery.

REFERENCE:

Visscher K, Boyd K, Ross DC, Amann J, Temple C, "Refining perforator selection for DIEP breast reconstruction using transit time flow volume measurements," J Reconstr Microsurg. 2010; 26(5): 285-90. (Transonic Reference # 10717AHM)

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Signature Annotated Microvascular References

1 Smith RM, Kang V, Al-Khudari S, "Vessel selection and free flap monitoring in head and neck microvascular reconstruction," World Journal of Otorhinolaryngology 2015 Feb; 5(1): 5-13. (Transonic Reference # 10250AHR) *"Surgical complications are not uncommon during microvascular free flap reconstructions. They prolong the procedure and can lead to the need for time-consuming surgical re-explorations."*

2 Chen WF, Zhao H, "Transit-time ultrasound technology-assisted lymphatic super-microsurgery," J Plast Reconstr Aesthet Surg. 2015 Nov; 68(11): 1627-8. *"The TTUT measurements consistently correlated with the surgeon's observations in all 28 lymphatic vessels — healthy-appearing lymphatic vessels demonstrated flow values higher than those from unhealthy-appearing lymphatic vessels. ...Based on the above findings, we concluded that TTUT holds promise in 1) guiding the lymphatic vessel selection, 2) confirming anastomotic patency, and that 3) the absence of "wash out" may not unequivocally indicate anastomotic occlusion."*

3 Selber JC, Garvey PB, Clemens MW, Chang EI, Zhang H, Hanasono MM, "A Prospective Study of Transit Time Flow Volume (TTFV) Measurement for Intraoperative Evaluation and Optimization of Free Flaps," Plast Reconstr Surg. 2013; 131(2): 270-81. (Transonic Reference # 9762AHM) *"…TTFV (Transit-time Flow Volume) provides novel physiologic flap data and identifies flow anastomoses and higher-flow venae comitantes. These data have clinical value in microsurgery and hold the potential to reduce microvascular complications and improve outcomes."*

4 Visscher K, Boyd K, Ross DC, Amann J, Temple C, "Refining perforator selection for DIEP breast reconstruction using transit time flow volume measurements," J Reconstr Microsurg. 2010; 26(5): 285-90. (Transonic Reference # CV-9953AHM) *This study evaluated the correlation among computed tomographic angiography (CTA), intraoperative TTFV measurements, and hand-held Doppler signals in identifying perforators in ten consecutive free DIEP breast reconstructions. "Of the 54 perforators identified, TTFV showed arterial flow waveforms in 15 of 16 perforators identified by CTA and in 2 of the remaining 38 vessels. The sensitivity and specificity of TTFV in identifying arterial perforators were 94 and 95%, respectively. In contradistinction, hand-held Doppler was misleading in 70% of vessels. TTFV distinguishes arterial from venous waveforms in vessels that appear arterial by hand-held Doppler signals. CTA and TTFV are highly correlated, and the use of TTFV may prevent poor perfusion seen in some DIEP flaps."*

5 Herberhold S, Röttker J, Bartmann D, Solbach A, Keiner S, Welz A, Bootz F, Laffers W, "Evaluation and Optimization of Microvascular Arterial Anastomoses by Transit-Time Flow Measurement," Laryngorhinootologie 2015 Dec 15. (Transonic Reference # 10035AHM) *This prospective study combined ultrasound imaging and transit-time flow measurements to assess anastomotic quality of 15 radial forearm flaps. ..."Results: Mean blood flow immediately after opening the anastomosis and 15 min later were 3.9 and 3.4 ml/min respectively showing no statistically significant difference (p=0.96). ...Conclusion: Transit time flow measurement contributes to the improvement of anastomotic quality and therefore to the overall outcome of radial forearm flaps. The examined measurement method provides objective results and is useful for documentation purposes."*

6 Takanari K, Kamei Y, Toriyama K, Yagi S, Torii S, "Differences in blood flow volume and vascular resistance between free flaps: assessment in 58 cases," J Reconstr Microsurg. 2009 Jan; 25(1): 39-45. (Transonic Reference # 10313AH) *"We investigated blood flow in the flap by transit-time ultrasound flowmeter in 58 free-flap transfers. Flow volume was compared between flap tissues as vascular resistance in the flap was calculated. Fasciocutaneous and osteocutaneous flaps had relatively low blood flow volume, myocutaneous flaps had more, and intraperitoneal flaps had still higher blood flow volume. These differences were statistically significant. Vascular resistance significantly decreased in the same order of comparison. Our findings will help in selecting the most suitable flaps for reconstructive surgery."*

7 Lorenzetti F, Giordano S, Tukiainen E, "Intraoperative hemodynamic evaluation of the latissimus dorsi muscle flap: a prospective study," J Reconstr Microsurg. 2012; 28(4): 273-8. (Transonic Reference # 10035AHM) *Measurements of blood flow were performed intraoperatively in 27 patients using a 2- to 5-mm probe ultrasonic transit-time flowmeter around the dissected vessels. "Registrations were made in the thoracodorsal artery before and after harvesting the flap, after compressing and cutting the motor nerve, and after anastomosis. Mean blood flow of in situ harvested thoracodorsal artery as measured intraoperatively by transit-time flowmeter was 16.6 ± 11 mL/min and was significantly increased after raising the flap to 24.0 ± 22 mL/min ($p < 0.05$); it was 25.6 ± 23 mL/min after compressing the motor nerve and was significantly increased after cutting the motor nerve to 32.5 ± 26 mL/min ($p < 0.05$). A significant increase of blood flow to 28.1 ± 19 mL/min was also detected in the thoracodorsal artery after flap transplantation with end-to-side anastomosis ($p < 0.05$)."*

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