

## Intraoperative Flow Measurement of Saphenous Vein Graft: Transit Time Flowmetry Measurement Versus Free Flow Measurement

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### Abstract

**Background:** According to European Association for Cardio-Thoracic Surgery (EACTS) and European Society of Cardiology (ESC) guidelines, Transit time flowmetry (TTFM) is recommended for intraoperative graft patency verification during coronary artery bypass grafting (CABG). Studies are done to find out the accuracy and precision of the TTFM technique to measure left internal mammary artery (LIMA) blood flow when compared to its free flow. But none of the studies have been done so far on saphenous vein graft (SVG) graft flow measurement accuracy and precision with TTFM technique when compared to free flow measurement.

**Methods:** The TTFM flow measurement and free blood flows was evaluated in 48 SVG grafts in patients undergoing beating heart coronary artery bypass surgery (OPCABG) using SVG as one of a conduit. The measurements were done after doing proximal anastomosis of SVG to aorta and before doing distal coronary anastomosis. Simultaneous reading was taken with TTFM device and free flow through the graft.

**Results:** The TTFM reading and free flow measurement results difference were statistically not different.

**Conclusions:** The difference between TTFM measurements and free flow measurements were statistically not significant. TTFM can be taken as an accurate indicator of SVG flow during CABG with clinically acceptable precision.

**Keywords:** Transit Time Flowmetry; Graft Flow; CABG; Saphenous Vein Graft.

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### Introduction

Coronary artery bypass grafting (CABG) is one of the most frequently performed surgical procedures for coronary artery disease [1] and it is a reference standard for revascularization of multivessel coronary artery disease [2]. TTFM is

an effective method for evaluation of graft patency at intraoperative period. The intraoperative monitoring of graft flow, and transit time flowmetry (TTFM) is the most commonly applied technique as per European guidelines during myocardial revascularization [3]. Specific cut-off values for TTFM have been recommended to avoid graft occlusion postoperatively by European Association for Cardio-Thoracic Surgery (EACTS) and European Society of Cardiology (ESC) [3,4,5]. There are only few studies on accuracy and precision of TTFM to determine the graft blood flow. Lundell et al. [6] conducted experiments on sheeps with TTFM and concluded that the TTFM can be used with a small variability. Where as Laustsen et al. [7] conducted a study on humans and concluded that

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the technique can give fast, precise measurements of the actual blood flow [7]. Both of the studies used free blood flow as reference standard to compare with TTFM measurement. Amin S et al. [8] is the only study done to evaluate the accuracy of TTFM in LIMA flow. the concluded that TTFM is an accurate indicator of LIMA blood flow during CABG with a clinically acceptable precision. But none of the studies have been done so far on saphenous vein graft (SVG) graft flow measurement accuracy and precision with TTFM technique when compared to free flow. We conducted an observational study to evaluate the TTFM precision and accuracy on blood flow measurement of GSV, by comparison of free flow to TTFM measurement.

### Patients and Methods

We included 48 number of consecutive SVG grafts of the patients undergoing elective myocardial revascularization using SVG as one of the conduits. the were evaluated with TTFM measurement with concomitant measurement of free blood flow. Only (Off pump Coronary artery bypass grafting) OPCAB were included, as proximal anastomosis had to be done first to evaluate the blood flow through the SVG. A mean arterial pressure (MAP) of 70 to 80 mmHg was maintained in all patients during the measurement. the probe size were decided as per the visual estimation of the SVG size. Usually we used 3 or 4 mm size probe. The free blood flow through the SVG is determined by collecting the blood for 15 seconds time in all patients. The amount of blood collected was multiplied with four times to get an estimation of flow for one minute. The TTFM was measured simultaneously during free flow calculation. Both the measurements were determined in ml/min. The Collected blood was returned to the patient via central line by anaesthetist. The primary study outcomes were to find out variation in blood flow measured by TTFM and the free blood flow with the aim of assessing the accuracy and precision of TTFM flow measurement in an SVG. TTFM measurements were performed using Veri QC device (Medistim ASA, Oslo, Norway). The difference noted in TTFM flow to free flow, were interpreted in percentage. Bland-Altman analysis was used to determine the over or underestimation the derived measurements

### Statistical Analysis

Continuous variables are reported as mean  $\pm$  standard deviation and were compared using the t test for normal distributions and to Bland-

Altman analysis was applied to evaluate under and overestimation of the measurements. Reported p-values of  $p < 0.05$  was considered statistically significant. Statistical analysis was performed in MedCalc statistical software.

### Results

48 TTFM flow measurements were included in the analysis. 4 mm probe was used in 42 number of grafts and 3 mm probe was used in 6 graft measurement. Based on the percentage analysis, TTFM flow results were higher than free flow results in all 48 of measurements. The average flow was 207 ml/min by TTFM and 195 ml/min by free flow method (Fig. 1,2). The average acoustic coupling index (ACI) was 84%. The Bland-Altman analysis done showed that the TTFM measurements and free flow measurements were almost (Fig. 3). The TTFM reading and free flow measurement results difference

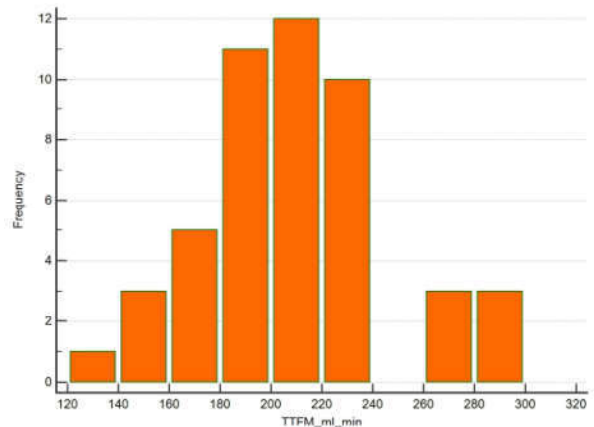


Fig. 1: Histogram showing graft flow measured using TTFM in ml/min

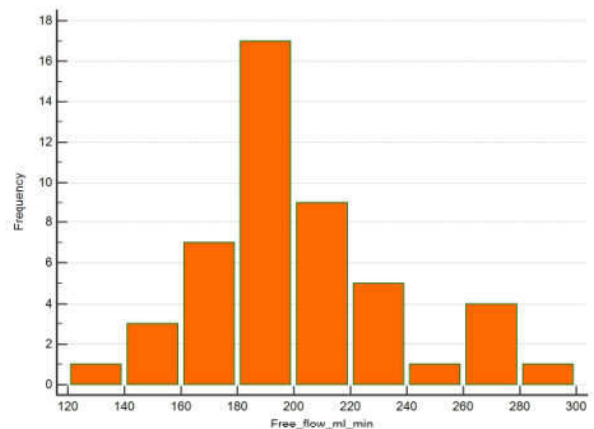


Fig. 2: Histogram showing free graft flow measurements in ml/min

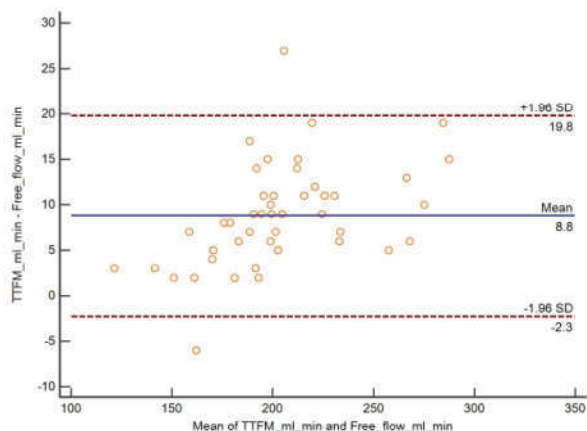


Fig. 3: Bland-Altman plot showing difference between graft flows determined by Transit time flowmetry (TTFM) and Free Flow.

## Discussion

The Transit time flowmetry (TTFM) for evaluation of SVG graft flow compared with free flows were determined during OPCABG in 48 SVG grafts. All TTFM measurements showed higher flows when compared to free flow measurement. TTFM flow measurements were 6% more when compared with free flow measurement. TTFM is an effective method for evaluation of graft patency at intraoperative period. The intraoperative monitoring of graft flow, and transit time flowmetry (TTFM) is the most commonly applied technique as per European guidelines during myocardial revascularization [3,5]. Specific cut-off values for TTFM have been recommended to avoid graft occlusion postoperatively by European Association for Cardio-Thoracic Surgery (EACTS) and European Society of Cardiology (ESC) [3,4,5]. There are only few studies on accuracy and precision of TTFM to determine the graft blood flow. Lundell et al. [6] conducted experiments on sheeps with TTFM and concluded that the TTFM can be used with a small variability. where as Laustsen et al [7] conducted a study on humans and concluded that the technique can give fast, precise measurements of the actual blood flow [7]. Both of the studies used free blood flow as reference standard to compare with TTFM measurement. Amin S et al. [8] is the only study done to evaluate the accuracy of TTFM in LIMA flow. the concluded that TTFM is an accurate indicator of LIMA blood flow during CABG with a clinically acceptable precision. But none of the studies have been done so far on saphenous vein graft (SVG) graft flow measurement accuracy and

precision with TTFM technique when compared to free flow. Amin S et al. [8] have concluded in one of the observation that accuracy of TTFM with SVG has to be studied. Hence this study was undertaken. We found that the TTFM technique has a high accuracy in determining blood flow through the SVG. In the actual clinical setting the average flow through the SVG grafts are around 30 to 90 ml/min, hence at these flow levels TTFM is a good indicator of actual blood through the SGV grafts.

## Conclusion

The difference between TTFM measurements and free flow measurements were statistically not significant. TTFM can be Taken as an accurate indicator of SVG flow during CABG with clinically acceptable precision.

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