

Intraoperative coronary grafts flow measurement using the TTFM flowmeter: results from a domestic sample

Medida do fluxo intraoperatório com fluxômetro TTFM nos enxertos coronários: resultados de amostra nacional

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Abstract

Objective: To evaluate intraoperative graft patency and identify grafts under risk of early occlusion.

Methods: Fifty four patients were submitted to coronary artery bypass surgery and the graft flow was assessed by the Flowmeter (Medtronic Medistim), which utilizes the TTFM method. Three patients had left main disease and 48 had normal or mildly reduced left ventricular function.

Results: In hospital mortality was 3.7% (two patients), one for mesenteric thrombosis and one due to cardiogenic shock. Seventeen patients (34%) were submitted to off pump CABG. Arterial Graft flow measures ranged from 8 to 106 ml/min (average 31.14 ml/min), and venous grafts flow ranged from 9 to 149 ml/min (average 50.42 ml/min).

Conclusion: Flowmeter use represents higher safety both for patients and surgeons. Even under legal aspects, the documentation provided by the device can avoid future questionings.

Descriptors: Flowmeters. Myocardial revascularization. Coronary artery bypass. Angina pectoris.

Resumo

Objetivo: Avaliar a perviedade dos enxertos no intraoperatório e identificar enxertos com risco de oclusão precoce.

Métodos: Cinquenta e quatro pacientes foram submetidos à revascularização do miocárdio e foi utilizado o fluxômetro (Medtronic Medi-Stim) que utiliza o método de tempo de trânsito (TTFM) para avaliação do fluxo nos enxertos. Três pacientes tinham lesão de tronco de artéria coronária esquerda e 48 apresentavam função ventricular normal ou pouco comprometida.

Resultados: A mortalidade hospitalar foi de dois (3,7%) pacientes, um por trombose mesentérica e outro por choque cardiogênico. Dezesete (31,4%) pacientes foram operados sem circulação extracorpórea (CEC). O fluxo no enxerto

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Abbreviations, acronyms and symbols

CPB	Cardiopulmonary Bypass
FC	Functional Class
DF%	Diastolic filling
PI	Pulsatility index
TTFM	Transient time flowmeter
LV	Left ventricle

arterial variou de 8 a 106 ml/min, com média de 31,14 ml/min, e nos enxertos venosos de 9 a 149 ml/min, com média de 50,42 ml/min.

Conclusão: O fluxômetro representa maior segurança para o cirurgião e para o paciente. Até mesmo sob o aspecto legal essa documentação dos enxertos prévios evitará questionamentos futuros.

Descritores: Fluxômetros. Revascularização miocárdica. Ponte de artéria coronária. Angina pectoris.

INTRODUCTION

The low flow in arterial and venous grafts in coronary artery bypass grafting may represent a high risk of early occlusion with increased perioperative infarction and increased mortality. Some authors have reported early failures in the graft LITA 5% and saphenous vein up to 25% [1-5].

The presence of pulsatility in the grafts does not ensure patency thereof and may represent only high flow resistance.

Several methods have been described for early assessment of graft patency such as coronary tomography and angiography in early postoperative and use of intraoperative graft flow measurement systems.

The use of ultrasound TTFM (R) (transient time Flowmeter) directly over the graft provides data on the flow (ml / min), pulsatility index (PI) and percentage of diastolic flow in grafts that, taken together, allow to assess the patency therein. There are large number of publications in international literature standardizing data [6-10] and suggesting cutoff values to indicate revision of anastomosis. However, the literature lacks results in Brazilian patients.

METHODS

Population studied

In a group of 54 consecutive patients referred for CABG, we used the technique of intraoperative flow analysis using the Flowmeter (Medtronic Medi-Stim AS Inc). Thirty-nine patients were male and 15 female, with ages ranging from 27 to 83 years, with a mean of 61.26 ± 11.0 years and a median of 60 years.

Among the comorbidities, we identified: hypertension in 42 patients, diabetes in 16, dyslipidemia in 24, smoking in 15, infarction in 24, obesity in 3, chronic obstructive pulmonary disease in 3, non-dialysis renal failure in 3.

With respect to characteristics related to coronary disease, we observed three patients with lesion of the left coronary artery, 15 patients in functional class (FC) I or II angina and 39 with class III or IV (Canadian Cardiovascular Society), five patients had previously placed stent.

Ventricular function was normal or moderately impaired was assessed in 48 patients by ventriculography in the hemodynamic study and six had severe dysfunction of the left ventricle (LV), and two arrived in the operating room with intra-aortic balloon. Thirty-seven (68.5%) patients underwent surgery with cardiopulmonary bypass (CPB) and 17 without CPB (31.5%).

Surgical technique

After sternotomy and exposure of the heart, heparinization was performed with 4 mg / kg in patients operated with CPB. Cannulation of the ascending aorta and single venous cannula was performed. CPB was started in normothermia and performed with aortic clamping with antegrade hypothermic blood cardioplegia. The off-pump patients were heparinized with 2 mg / kg and it was employed in all the preconditioning technique previously described [12]. The left internal thoracic artery was used in 48 (88.8%) patients. The CPB time ranged from 40 to 160 minutes, with an average of 80.18 minutes, anoxia time ranged from 18 to 90 minutes, with an average of 58.16 minutes. At the end of the operation, with the patient off -pump and before protamine infusion, measurements were taken with the Flowmeter (Medtronic Medi-Stim AS Inc), with the same procedure adopted for off-pump patients. Upon finding that the grafts were functioning normally, it was administered protamine and further steps with the Flowmeter before closing the patient.

The equipment used consisted of a permanent console and disposable probes with the possibility of up to 50 uses each. The measurement was used by positioning the probe so as to engage the graft, obtaining measurements in real time on the screen of the device.

The measurement with Flowmeter was performed with 3 mm probes for the left internal thoracic artery and with 4 mm probes for the saphenous vein grafts. The graft was considered patent if the three parameters were adequate: the flow in the graft, the PI and the diastolic filling (DF%).

Flow curve - represents the flow (run-off) through the coronary artery, it is always coupled to the flow electrocardiogram and shows systolic, diastolic and mean flow. The flow rate can be altered by several factors: average artery pressure, coronary bed quality, size of native coronary artery spasms in the graft and / or possibly even in the coronary artery. A low flow does not necessarily represent involvement of the anastomosis.

Diastolic Filling Percentage (% DF) - Recent studies [8,9] suggest that diastolic filling represents the most important indicator of graft patency. It is obtained through the full diastolic flow divided by the systolic flow + diastolic flow: $DF \% = S \text{ Total Diastolic Flow} / \text{Systolic Flow} + \text{Diastolic Flow}$.

In summary, the percentage of diastolic filling of the coronary artery shall be greater than 60% in most grafts. The quantification of diastolic filling is important in situations of low flow, averaging less than 10 ml / min.

The pulsatility index (PI) - is an absolute number obtained by the difference between the maximum flow and minimum flow divided by average flow: $PI = \text{Maximum Flow} - \text{Minimum Flow} / \text{Medium Flow}$. It shall range from 1 to 5, values above 5 represent problems with the coronary graft anastomosis.

Statistical method

A comparison of the flux between the arterial and venous grafts was performed with non-parametric test and Mann-Whitney test. The comparison between the three vein grafts used in different territories was performed with the nonparametric Kruskal-Wallis.

RESULTS

Initially, we compared the flow in arterial and venous grafts and found that in arterial grafts varied from 8 ml / min to 106 ml / min, with a mean of 31.14 ± 18.13 ml / min, and a median of 27.5 ml / min, whereas in vein grafts, the flow ranged from 9 to 149 ml / min, with a mean of 50.42 ± 28.42 ml / min and a median of 44 ml / min ($P < 0.0001$). We compared the pattern of saphenous vein graft in three different areas: diagonal, posterior interventricular artery and the right coronary artery marginal left. The average flux for the diagonal was 49.38 ± 23.11 ml / min for the posterior interventricular branch 46.11 ± 12 ml / min and left marginal arteries, 51.84 ± 28.21 ml / min ($P = 0.789$).

DISCUSSION

With the development of coronary artery bypass grafting without cardiopulmonary bypass [12] and / or minimally invasive, concern about the quality of anastomoses has become ever present.

The Flowmeter is a simple, easy and fast method, providing immediate information on the conditions of the coronary anastomosis.

The assessment of coronary grafts flow in the intraoperative or immediate postoperative period can be carried out in several ways: electromagnetic or Doppler angiography [6-8,13].

In the present study, the flow of the internal thoracic artery was significantly lower than the flow of saphenous vein grafts.

The flow of venous grafts was not influenced by the different coronary territories: diagonal artery, posterior interventricular artery and left circumflex artery. In two (3.7%) patients (one artery and one vein graft), it was found that fluxes below 8 ml / min with PI above 5. The anastomoses were revised and the flowmetry was normalized.

Di Gianmarco [9] studied 157 patients using Flowmeter, with identification of up to 3% of anastomoses at risk, and concluded to be an easy and effective method for the evaluation of the graft.

Louagie et al. [7] reported Flowmeter with 900 grafts analyzed and identified seven (2%) patients with altered flow curve, with low diastolic filling and high PI, requiring that the anastomosis was redone.

CONCLUSION

The Flowmeter is safer for the surgeon and for the patient, ensuring that the operation was technically well done. Even under the legal aspect, that documentation of patent grafts avoids future questions.

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