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Evaluation of Blood Hemodynamics in Vascular Grafts after Total Arterial Coronary Revascularization

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ABSTRACT

Arterial grafting has increasingly been advocated for the treatment of coronary artery disease in an attempt to improve the long-term results. In the quest to perform routine total arterial revascularization, composite Y graft methods are gaining popularity. The aim of our study was to evaluate whether blood flow in the left internal thoracic artery can provide sufficient perfusion to the entire cardiac muscle per se. Twenty patients with severe coronary artery stenosis who underwent complete arterial coronary revascularization using a composite graft entered our study. Blood flow in thoracic trunk was evaluated in three phases: cross-clamp on, cross-clamp off, and after weaning the patient from cardiopulmonary bypass. Mean arterial blood pressure in the thoracic trunk in these various positions was 62.7±3.7. left internal thora cic artery can provide sufficient blood flow to the cardiac muscles for both rest and exercise conditions.

INTRODUCTION

Cardio vascular diseases are the number one cause of death globally. An estimated 17.5 million people died from these diseases in 2012, representing 31% of all global deaths [1]. Coronary revascularization, comprising coronary artery bypass surgery [CABG] and percutaneous coronary intervention, is amongst the most valuable treatment methods for this complication, and is one of the most common major medical procedures undertaken in the united states, with over 1 million procedures performed annually [2].

Although CABG is extremely effective for symptomatic relief and prognostic improvement in patients with coronary artery disease and is the preferred treatment method for high-risk patients, it is not devoid of complications and the long-term benefits are directly related to continuing conduit patency. Approximately 10–15% of vein grafts occlude during the first year after operation. About half of the vein grafts are only effective for a period of 5 to 10 years [3]. By 10 years after surgery, about 60% of vein grafts are patent, only 50% of which remain free of significant stenosis [4].

Coronary artery bypass surgery using the in situ internal thoracic artery has substantially improved graft patency compared with revascularization with saphenous vein grafts [5], and excellent long-term patency rates [88-95% over

10-15 years period] have been observed for the such grafting [6]. Researches indicate that total myocardial revascularization with composite arterial grafts provide superior clinical results and improve the patient outcome [7]. Composite arterial grafts for coronary artery bypass grafting surgery allow complete arterial revascularization but are limited by the inflow of a single internal thoracic artery supplying all the grafted vessels. Therefor the aim of our study was to evaluate whether blood flow in the left internal thoracic artery [LITA], which is the main arterial trunk supplying blood to the heart in complete arterial coronary revascularization, can provide sufficient perfusion to the entire cardiac muscle per se.

MATERIALS AND METHODS

Twenty patients (15 male and 5 female) with severe coronary artery stenosis who had severe coronary artery stenosis and underwent complete arterial coronary revascularization using a composite graft (Y graft technique (8)), entered our study. In all these patients LITA was used as the main grafted arterial trunk. The other arterial graft either included the right ITA or the radial artery. The ethical committee board approved the study.

Arterial blood flow was measured by H2MB or H3MB (2.5 or 3.0-mm), handle-style, perivascular transit-time Doppler flow probes connected to an HT363 dual channel flow meter (Transonic Systems Inc, Ithaca, NY). The probe was placed around the proximal LIMA, after the fascia around the artery had been dissected free. Sterile gel was used for acoustic coupling (Aquasonic 100, Parker Laboratories Inc, Fairfield, NJ). Blood flow was measured over a minimum of 12 heartbeats or 10 seconds, and was expressed as mean blood flow (MBF)in mL/min. We studied the thoracic trunk flow in three phases. First, after all coronary graft anastomoses had been performed, but before removal of the aortic cross-clamp (cross-clamp ON). Thus, all three coronary artery territories were being perfused through the grafts but there was no flow through the native coronary circulation. Second, after unclamping the aorta but with full cardiopulmonary bypass support maintained (cross-clamp OFF). This detected the immediate effect of reintroducing native coronary artery flow from the aortic root. Third, after weaning from cardiopulmonary bypass with the heart working against the systemic vascular resistance (post-bypass).

RESULTS

Twenty patients entered the study with the demographic factors described in Table 1. Sixty percent of the patients had history of hypertension, 10% were smokers, 40% suffered from diabetes, and 5% had hyperlipidemia.

In all the patients LITA was used as the main grafted arterial trunk. The other arterial graft either included the right ITA (3 patients; 15%) or the radial artery (17 patients; 85%). The mean pomp duration was 72.9±12.6 min and the mean aortic clamp duration was 59.7±12.6.

Table 2 demonstrates the arterial blood flows in mL/min. Mean arterial blood pressure in the thoracic trunk in these various positions was 62.7±3.7, and mean numbers of grafts were 3.9±0.9 for each patient.

As evident in Table 3, there is a statistically significant difference in the blood flow when the patient is on cardiopulmonary pump with the aorta clamped, and when the patient is off-pump (P value<0.05). In former condition, blood runs only through the LITA to the heart and there is no supply through the patients native coroners; while, in the latter situation, blood is supplied by both coronary grafts and the patients native coroners.

Table 1. Demographic factors of the patients

	Age (Yr)	Weight (Kg)	Height (Cm)	BSA	BMI
Mean ± SD	62.8±8.0	74.4±10.9	169.8±8.2	1.83±0.7	25.7±3.0

**BSA= body surface area*
**BMI= body mass index*
**SD=standard deviation*

Table 2. Arterial blood flows measured in mL/min

Blood flow in LITA	Minimum (ml/min)	Maximum (ml/min)	Mean±SD
Aorta and composite clamped	20	130	70±30
Aorta clamped and composite unclamped	90	300	155±50
Aorta unclamped and composite clamped	10	50	37±10.5
Aorta and composite unclamped	40	120	78.5±20.4
Patient off-pump and composite clamped	10	55	28.2±10.4
Patient off-pump and composite unclamped	30	110	61.5±17.4

**LITA=left internal thoracic artery*
**SD=standard deviation*

Table 3. Comparison of coronary flow reserve in clamp on and pump on status

	Minimum (ml/min)	Maximum (ml/min)	Mean±SD	P value
Coronary flow reserve clamp on	90.0	300.0	155.4±50.3	0.00
Coronary flow reserve pump on	30.0	110.0	61.5±17.4	

**SD=standard deviation*

DISCUSSION

Arterial grafting has increasingly been advocated for the treatment of coronary artery disease in an attempt to improve the long-term results (9, 10). In the quest to perform routine total arterial revascularization, composite Y graft methods are gaining popularity (11, 12). The aim of our study was to evaluate whether blood flow in the LITA, which is the main arterial trunk supplying blood to the heart in this method of revascularization, can provide sufficient perfusion to the entire cardiac muscle per se. All patients in this study had revascularization of all three coronary territories using a composite arterial graft based on the LITA, which remains attached to the subclavian artery. Our data indicate that LITA along with RITA or radial artery as a composite graft, has the ability to supply blood to the entire left ventricle. We also proved that in the composite graft method the LITA can also provide sufficient blood supply for the right coronary artery.

In a study conducted on 163 patients undergoing total arterial revascularization using composite grafts, Pevni and colleagues found that if the operation is performed on patients with severe coronary artery stenosis (>70%), the competitive flow in the native coronary artery can no longer cause occlusion or severe narrowing of the internal thoracic artery supplying this coronary vessel (13). Our findings are in agreement with this study indicating that if the procedure is performed on patients with >75% coronary artery stenosis, the amount of blood which flows in the native coroners after weaning from cardiopulmonary bypass devise will be ineffective in competing with the blood flow in new arterial grafts. The results of another study in 2006, indicated The arterial conduit flow reserve (calculated by dividing the maximum potential flow by the actual flow at the end of the operation) was found to be 2.2 in patients with Y graft revascularization (14). The flow reserve in LITA was estimated to be 2.52 in our research which is higher compared to that study; however, both studies indicate that there is a considerable reserve allowing for increased flow during times of increased requirements, such as exercise.

CONCLUSION

Based on the results of our study, LITA can provide sufficient blood flow to the cardiac muscles for both rest and exercise conditions.

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