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Comparative analysis of the patency of the internal thoracic artery in the CABG of left anterior descending artery: 6-month postoperative coronary CT angiography evaluation

Análise comparativa da perviedade das artérias torácicas internas na revascularização da região anterior do coração. Avaliação por angiotomografia no 6º mês de pós-operatório

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Abstract

Objective: To assess the patency of the pedicled right internal thoracic artery with an anteroaortic course and compare it to the patency of the left internal thoracic artery, in anastomosis to the left anterior descending artery in coronary artery bypass grafting by using coronary CT angiography at 6 months postoperatively.

Methods: Between December 2008 and December 2011, 100 patients were selected to undergo a prospective coronary artery bypass grafting procedure without cardiopulmonary bypass. The patients were randomly divided by a computer-generated list into Group-1 (G-1) and Group-2 (G-2), comprising 50 patients each, the technique used was known at the beginning of the surgery. In G-1, coronary artery bypass grafting was performed using the left internal thoracic artery for the left anterior descending and the free right internal thoracic artery for the circumflex, and in G-2, coronary artery bypass grafting was performed using the right internal thoracic artery pedicled to the left anterior descending and the left internal thoracic artery pedicled to the circumflex territory.

Results: The groups were similar with regard to the preoperative clinical data. A male predominance of 75.6% and 88% was observed in G-1 and G-2, respectively. Five patients migrated from G-1 to G-2 because of atheromatous disease in the ascending aorta. The average number of distal anastomoses was 3.48 (SD=0.72) in G-1 and 3.20 (SD=0.76) in G-2. Coronary CT angiography in 96 re-evaluated patients showed that all ITAs, right or left, used in situ for the left anterior descending were patent. There were no deaths in either group.

Conclusion: Coronary artery bypass grafting surgery involving anastomosis of the anteroaortic right internal thoracic artery to the left anterior descending artery has an outcome similar to that obtained using the left internal thoracic artery for the same coronary site.

Descriptors: Mammary Arteries. Myocardial Revascularization. Cardiopulmonary Bypass. Coronary Artery Disease.

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Deininger MO, et al. - Comparative analysis of the patency of the internal thoracic artery in the CABG of left anterior descending artery: 6-month postoperative coronary CT angiography evaluation

Rev Bras Cir Cardiovasc 2014;29(2):192-201

Abbreviations, acronyms & symbols	
RITA	Right internal thoracic artery
AIB	Anterior interventricular branch
CABG	Coronary artery bypass grafting
LITA	Left internal thoracic artery
CPB	Cardiopulmonary bypass
CX	Circumflex
CAD	Coronary artery disease
ITA	Internal thoracic arteries

Resumo

Objetivo: Analisar a perviedade da artéria torácica interna direita pediculada, anteroaórtica em anastomose para o ramo interventricular anterior na revascularização do miocárdio, em relação à artéria torácica interna esquerda, com o uso de angiotomografia coronária, no 6° mês de pós-operatório.

Métodos: No período de dezembro de 2008 a dezembro de 2011, 100 pacientes foram selecionados, prospectivamente, para cirurgia de revascularização do miocárdio sem circulação extracorpórea. Foram agrupados em Grupo-1 (G-1) e Grupo-2 (G-2), com 50 pacientes cada, randomização por computador e conhecimento da técnica no início da cirurgia. No G-1, os pacientes receberam artéria torácica interna esquerda para o ramo interventricular anterior e complementação da revascularização do miocárdio com a artéria torácica interna direita livre para ramos da circunflexa. Os pacientes do G-2 receberam artéria torácica interna direita pediculada para o ramo interventricular anterior e complementação da revascularização do miocárdio com artéria torácica interna esquerda, pediculada, para ramos da circunflexa.

Resultados: Os grupos eram semelhantes quanto aos dados clínicos de pré-operatório. Houve predominância do sexo masculino, 75,6% e 88% nos grupos 1 e 2 respectivamente. Cinco pacientes migraram do G-1 para o G-2 devido à doença ateromatosa na aorta ascendente. A média de anastomoses distais no G-1 foi de 3,48 (DP=0,72), e no G-2 foi de 3,20 (DP=0,76). Os resultados das angiotomografias coronarianas em 96 pacientes reestudados mostraram que todas as artérias torácicas internas, direita ou esquerda, utilizadas pediculadas para a região anterior do coração encontravam-se pérvias. Não houve óbitos em nenhum dos grupos.

Conclusão: A cirurgia de revascularização do miocárdio com utilização da artéria torácica interna direita pediculada, anterógrada para o ramo interventricular anterior, apresenta resultado semelhante ao da artéria torácica interna esquerda utilizada para essa mesma coronária.

Descritores: Artéria Torácica Interna. Revascularização Miocárdica. Circulação Extracorpórea. Doença da Artéria Coronariana

INTRODUCTION

The treatment of coronary artery disease (CAD) is one of the most investigated issues in the medical field worldwide and the surgery for coronary artery bypass grafting (CABG) remains an excellent therapeutic option for the treatment of obstructive CAD, especially in cases where there the choice of drug or percutaneous treatment.

The saphenous vein is still widely used for aortic/coronary graft, due to its ease of collection, preparation and be used for making multiple grafts. However, this graft may develop intimal hyperplasia and atherosclerotic lesion, showing occlusion rates of 10% to 15% in the first year after surgery; yet, after ten years only 60% of vein grafts are patent and of these only 50% are free of significant stenosis. In addition, complications may occur in the lower limb which its collection [1] was performed. The internal thoracic artery (ITA) rarely develops atherosclerosis, and its diameter is usually compatible with coronary artery to be revascularized.

Currently, several studies show the superiority of the use of both internal thoracic arteries (ITAs) in relation to the use of only one, in particular the use of the left internal thoracic artery (LITA) to the anterior interventricular branch (AIB), considered the gold standard in CABG because of the excellent long-term patency. However, the right internal thoracic artery (RITA) shows results very similar to those obtained by the LITA when used for the AIB, depending on the strategy for using it. Some authors observed that RITA performs better as a second arterial graft compared to the radial artery, especially in relation to the occurrence of cardiac events such as perioperative myocardial infarction (MI) due to vasospasm that can occur in up to 10% of patients [2].

The RITA when used for the right coronary artery (RCA) and its branches, showed no results similar to those obtained when used for the left coronary (LC) system, with patency similar to the saphenous vein. Thus, RITA became used for LC as compound graft with the LITA, as a free graft, retroaortic for branches of the circumflex (CX)[3], sometimes antegrade for AIB[4,5].

Deininger MO, et al. - Comparative analysis of the patency of the internal thoracic artery in the CABG of left anterior descending artery: 6-month postoperative coronary CT angiography evaluation

Rev Bras Cir Cardiovasc 2014;29(2):192-201

There is still a fear for the use of both ITAs in some subgroups of patients, such as elderly, obese and diabetic patients. However, some authors have observed that the skeletonization of ITAs and CABG surgery when performed without CPB cause a reduction in the incidence of sternal infection, and this benefit is more evident in diabetic patients, where there may be a 60% reduction in the occurrence of this complication, allowing removal of both ITAs, without offering additional risk for infectious complications of the sternum[6,7]. Others noted that the use of pedicled ITA and use of CPB are independent risk factors for mediastinitis in surgery for CABG[8].

Various arterial conduits are used aiming to reduce the likelihood of future reoperations, especially both ITAs, or an ITA combined with another compound graft, with "Y" anastomosis[9]. However, in this technique all the blood flow to the grafted coronary ends up being from only one source of supply, usually the LITA. A reduction in its flow, due to spasm, can result in drastic consequences such as global ischemia of the left coronary territory.

The hypothesis of our research is that if we use the antegrade RITA, in single or sequential graft, for the AIB territory, we could use the LITA to the territory of CX. Taking into account the excellent long-term results with the use of both ITAs and the fact that in this way, the entire left coronary system was revascularized with arterial grafts only, or that is, RITA and LITA, all *in situ*, allowing two sources of blood supply. This could decrease the chance of a patient requiring reoperation for myocardial revascularization. But for this surgery becomes routine therapeutic option, it is necessary that the RITA to the anterior region of the heart shows as good results as the LITA when used in this same manner.

The primary aim of this study was to assess the patency of the pedicled RITA used, in the anteroaortic position in anastomosis to the anterior region of the heart in CABG compared with LITA used for that region of the heart. The secondary aim was to assess the occurrence of death or cardiac events such as myocardial infarction (MI), recurrent angina or need for reintervention (reoperation for CABG or coronary angioplasty), as well as assessing the patency of the other grafts. We assessed the immediate surgical results and in a period of 6 months postoperatively.

METHODS

This study was performed upon presentation of its research protocol for the Research Ethics Committee of the Lauro Wanderley University Hospital of the Universidade Federal da Paraíba and Ethics Committee for Analysis of Research Projects (CAPPesq) of the Clinical Board of the Clinics Hospital and the Faculty of Medicine of the Universidade de São Paulo, under the research protocol number 0844/08, CAPPesq, December 17, 2008. This project was performed

with the approval of these committees and under the supervision of the Surgical Unit of Surgery Division of Coronary Heart Institute at Clinics Hospital of the Faculty of Medicine, Universidade de São Paulo.

The surgeries were performed from December 2008 to December 2011. For purposes of randomization, it was necessary for patients or guardians agree and sign the written informed consent (IC), after being informed of it by a member of staff. This research was designed presented as an assessment of 100 patients who underwent cardiac surgery for OPCAB, prospectively, randomly by computer taken before the beginning of the study and knowledge of the surgeon regarding the selected group only at the beginning of surgery, or that is, which graft would be placed in the AIB territory (RITA or LITA), patients did not know which technique would be used. The number of patients was calculated according to the probability of a difference of 15% occlusion higher than the standard, LITA to the RIA, for a value of error probability of 0.05 and a power of 80% sample with *P* of 0.05%.

There was no conflict of interest of none of the researchers involved in this research project.

Patients were selected from coronary angiographies, which were evaluated by at least two surgeons and the surgical team and they should reveal coronary artery disease in at least two vessels of the territory of the left coronary artery with significant stenosis (> 70%), presenting angina stable or unstable, urgent or emergency surgery, and left ventricular ejection fraction (LV-EF) of > 30%. Patients with coronary artery bypass grafting combined with another procedure, cardiogenic shock circulatory assistance, use of intra-aortic balloon pump, LV-EF < 30% and reoperations were excluded. Obese or diabetic patients were not excluded, or even it has not been established age limit. Once filled these criteria, the patient would be selected and invited to participate. In order to provide similarity to the groups, we draw two strategies of using the RITA and grouped the patients in Group-1 (G-1) and Group-2 (G-2), both with 50 randomized patients. Being comparatively studied the patency of the right and left internal thoracic arteries, they were dissected using skeletonization and used *in situ* for the AIB territory.

In G-1, the LITA was used *in situ* with anastomosis in the AIB territory, and complementing revascularization with the free RITA to the territory of CX, used in sequential anastomoses when needed, and another graft to the RC territory. In G-2, the RITA was used *in situ*, anterograde with anastomosis in the AIB territory and complementing revascularization with LITA, also *in situ* for the territory of CX, used in sequential anastomoses when needed, and another graft to the RC territory.

Clinical characteristics were cataloged during the preoperative period to assess the similarity between groups. The occurrence of perioperative MI was assessed considering ST segment elevation greater than 1 mm in the limb leads or 2

Deininger MO, et al. - Comparative analysis of the patency of the internal thoracic artery in the CABG of left anterior descending artery: 6-month postoperative coronary CT angiography evaluation

Rev Bras Cir Cardiovasc 2014;29(2):192-201

mm in precordial leads in at least two contiguous leads, or some area of necrosis that did not exist in the preoperative ECG. We also analyzed elevation of creatine kinase (CK-MB) above 100 IU/l in the first two days of postoperative troponin I level or above 2.5 ng/ mL within 48 hours after surgery, as quoted by Leal[10].

To assess the patency of coronary grafts we used multislice CT angiography studies with 64 channels in patients in both groups at six months after surgery. We used a Philips CT scanner (Brilliance CT). With schemes of 120 kV and irradiation 800-1000 mA, 0.67 mm cuts were performed, using wherever possible the 75% stage. The period of apnea to capture images was around 15 seconds. In patients with heart rate (HR) above 65 beats per minute (bpm) a beta-blocker (metoprolol) at a dose of 2.5 mg to 15mg (titrating to achieve HR less than 65 bpm) was used. As the patients had already undergone coronary artery bypass grafting, calcium score was not performed.

We performed a median sternotomy. Special attention was paid to pericardiotomy, once we opened it up along with the plane of the top of the ascending aorta and, thereafter, we proceeded to "U" opening. Thus, we leave a pericardial patch so that covering the RITA and avoiding that the latter be attached to the sternum. Figure 1 shows details of the opening of the pericardium.

Initially we performed an anastomosis in the AIB territory, then we performed an anastomosis in the RC territory. This strategy allows more securely the medial traction of the heart to expose the side wall, since it is higher, and sometimes can lead to hemodynamic instability. For better exposure of the coronary arteries, we used the Lima's point[11], suction stabilizer and intracoronary shunt to allow for more comfort during anastomosis.

When the RITA was used for the anterior region of the heart, it was positioned across the mediastinum anteriorly. Initially a tunnel with blunt dissection was performed through the pericardial and pleural fat, anterior to the right phrenic nerve at the most cranial portion of the aorta. Thus, the RITA is covered with mediastinal fat and pericardial patch, previously isolated, making a tunnel on the aorta, allowing the RITA stay in the free space between the aorta and the sternum, eliminating the possibility of the first attaches the latter (Figure 2).
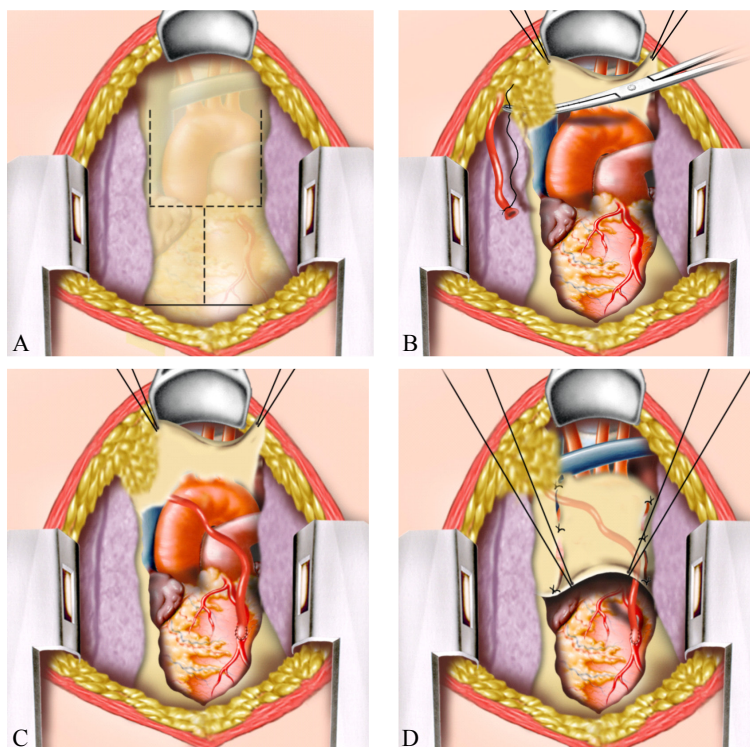

Fig. 1 - (A, B, C and B) Drawing showing details of the opening of the pericardium and tunneling through the mediastinal fat to protect the RITA

Deininger MO, et al. - Comparative analysis of the patency of the internal thoracic artery in the CABG of left anterior descending artery: 6-month postoperative coronary CT angiography evaluation

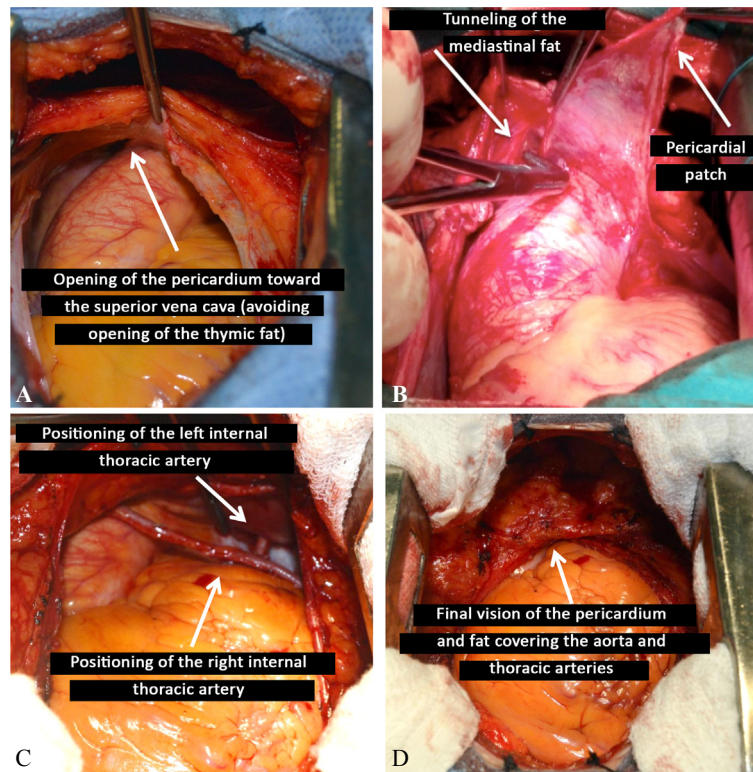*Rev Bras Cir Cardiovasc 2014;29(2):192-201*

Fig. 2 - (A, B, C and D) Surgical picture showing details of the pericardial patch, tunneling through the mediastinal fat and final vision with the right internal thoracic artery completely protected

It was assessed as the primary endpoint the graft patency of ITAs used to graft the RIA and as a secondary endpoint, the occurrence of death or cardiac events such as MI, recurrent angina and need for reoperation. The observation period lasted until the time of angiography, or that is, until the period of six months postoperatively. For statistical analysis, Chi-square and Fisher's exact test were used to compare proportions and Student's t test for numeric values with results expressed as mean and standard deviation. The software used was GraphPad Prism 5.2.

RESULTS

186 patients eligible for randomization were allocated. However, 86 were excluded due to reasons such as not patient acceptance and inability to continue the study. Therefore, these 100 patients were selected for randomization and grouped into G-1 and G-2, each with 50 patients.

In the G-1 there was migration of five patients to G-2, because the aorta showed atheromatous disease at the proxi-

mal anastomosis site and, because of this, we avoid handling. However, in one of these patients the RITA has not reached the place at AIB where the anastomosis would be performed due to the atheromatous disease of this coronary, which required its anastomosis in distal portion. So, we chose to perform anastomosis of the LITA for AIB and RITA in "Y" anastomosis into the left marginal (LM); thus, this patient was excluded since he no longer belongs to both groups. Thus, the G-2 now has 54 patients.

Clinical characteristics of preoperative parameters were similar in both groups. The data are shown in Table 1.

We found patients with obesity grade I to III, and it is not revealed an isolated risk factor for sternal infection. Not mediastinitis occurred in any patient of the two groups. One patient in the G-1 had osteomyelitis without progress to mediastinitis, whose symptoms appeared on day 42 postoperatively and required surgical intervention, with a good outcome after the procedure.

No patient had perioperative MI. One patient in the G-1 had angina in the 5th month after surgery, he performed coro-

Deininger MO, et al. - Comparative analysis of the patency of the internal thoracic artery in the CABG of left anterior descending artery: 6-month postoperative coronary CT angiography evaluation

Rev Bras Cir Cardiovasc 2014;29(2):192-201

Table 1. Variables analyzed in the preoperative period.

Preoperative variable	Group 1	Group 2	*P*
Gender:			
Male	34 (75.6%)	48 (88.8%)	NS
Female	11 (24.4%)	06 (12%)	
Age	M = 60.44	M = 59.44	NS
	DP = 9.08	DP = 9.85	
Stable angina	35 (77.7%)	44 (81.4%)	NS
Unstable angina	9 (20%)	10 (18.6%)	NS
CHF (NYHA) - I / II	32 (71.1%)	35 (64.8%)	NS
CHF (NYHA) - III / IV	13 (28.9%)	19 (35.2%)	
Previous MI > 30 days	24 (53.3%)	28 (51.8%)	NS
Previous MI < 30 days	4 (8.8%)	4 (7.4%)	NS
Smoking	22 (48.8%)	37 (68.5%)	0.083
Diabetes	21 (46.6%)	20 (37.03%)	NS
Dyslipidemia	36 (80%)	50 (92.5%)	NS
Obesity (BMI > 30)	11 (24.2%)	16 (29.6%)	NS
Arterial Hypertension	30 (66.6%)	37 (68.5%)	NS
Previous angioplasty	17 (37.7%)	18 (33.3%)	NS
LVEF 30/40	1 (2.2%)	2 (3.7%)	NS
LVEF 41/50	9 (20%)	9 (16.7%)	NS
LVEF > 50	35 (77.8%)	43 (79.6%)	NS
Emergency surgery	9 (20%)	11 (20.3%)	NS
CPB use	0	0	
COPD	6 (13%)	6 (11.1%)	NS
Biarterial commitment	1 (2.3%)	5 (9.2%)	NS
Triarterial commitment	19 (42.2%)	29 (53.7%)	NS
Multiarterial commitment	25 (55.5%)	20 (37.1%)	NS

CHF - congestive heart failure, NYHA - New York Heart Association, MI - myocardial infarction, BMI - Body mass index, EF - ejection fraction, LV - left ventricle, CPB - cardiopulmonary bypass, COPD - Chronic obstructive pulmonary disease, M - Mean, SD - standard deviation, NS - not significant

nary angiography, which showed graft patency of the LITA and RITA; this showing restenosis of angioplasty for RC that was performed prior to surgery. One patient in the G-2 had angina on 3rd month postoperatively; myocardial scintigraphy was performed that showed signs of ischemia, then performing coronary angiography showing patency of the three arterial and one venous grafts.

The length of ICU stay ranged from 2 to 5 days in G-1 and in G-2 from 2 to 4 days. The main reason for the increase in ICU stay was the need for reoperation for bleeding in G-1 and the occurrence of postoperative arrhythmia in the G-2. The hospital stay ranged from 6 to 11 days in G-1 and in G-2 from 6 to 9 days.

There were no deaths in either group, nor any permanent neurological complications, or need for revascularization, percutaneous or surgical, in any patients in the two groups during the observation period of 6 months. Table 2 shows surgical and postoperative data.

Coronary angiography was performed at 6 months postoperatively and was re-studied in 96 patients. None of the ITAs, both right or the left, grafted in AIB, showed occlusion or stenosis. Table 3 shows the results of CT angiography.

On angiography, a patient from G-1 presented with occlusion of the distal anastomosis of the free RITA on a LM branch, but on this exam the coronary artery showed no obstructive lesion and myocardial scintigraphy showed no ischemia in this area. Another patient in this group had moderate lesion in the proximal anastomosis of the RITA in the ascending aorta; also, myocardial scintigraphy was performed and showed no ischemia. Another patient in this group showed decrease in the caliber of the distal RITA anastomosed in the LM branch; on preoperative coronary angiography, this showed an obstructive lesion of 70% and angiography did not evidence obstructive lesion.

In two other patients there was evidence of mild stenosis at the proximal anastomosis of the RITA in the ascending aorta. In three patients the saphenous vein graft anastomosed to the RC territory presented occluded, but in none of these patients surgical or percutaneous reintervention was needed. In two patients, the RC was occluded with collateral filling and the other patient was asymptomatic without evident ischemia on myocardial scintigraphy; the distal bed of the right posterior descending coronary artery was of small caliber; so we chose the clinical follow-up.

Deininger MO, et al. - Comparative analysis of the patency of the internal thoracic artery in the CABG of left anterior descending artery: 6-month postoperative coronary CT angiography evaluation

Rev Bras Cir Cardiovasc 2014;29(2):192-201

Table 2. Surgical and postoperative data.

Surgical and postoperative data	Group 1	Group 2	P
Anastomoses / patient (M)	3.48 (DP=0.72)	3.2 (DP=0.76)	NS
Mortality	0	0	NS
Arrhythmia (AF / flutter)	6 (13%)	8 (14.8%)	NS
Bleeding volume	380 (DP=134.24)	350 (DP=117.95)	NS
Use of blood products	14 (31.1%)	10 (18.51)	NS
Reoperation for bleeding	2 (4.4%)	0	NS
Extubation in the OR	38 (84.4%)	52 (96.2%)	NS
Time of ICU stay (M)	2.6 (DP=0.83)	2.59 (DP=0.63)	NS
Time of hospital stay (M)	7.2 (DP=0.81)	7.09 (DP=0.78)	NS

AF - Atrial Fibrillation, OS - Operating Room, ICU - Intensive care unit, M - Medium, NS - not significant

Table 3. Results of coronary CT angiography. We compute the moderate, significant obstructive lesions or occlusions.

Results of CT angiography	Group 1 (44 angio tc)	Group 2 (52 angio tc)	P
LITA (No. anastomosis / patent)	44/44 (100%)	52/50 (96.15%)	NS
RITA (No. anastomosis / patent)	44/41 (93.18%)	52/52 (100%)	NS
Saphenous (No. anastomosis / patent)	30/26 (86.66%)	31/29 (87.09%)	NS
RA (No. anastomosis / patent)	2/1 (50%)	3/3 (100%)	NS

LITA - Left internal thoracic artery, RITA - Right internal thoracic artery, AR - Radial artery, CT Angiography - Multislice CT angiography studies with 64 channels, NS - Not significant

In G-2, coronary angiography of two patients showed occlusion of the LITA pedicle graft to the CX branches and they did not show obstructive lesions; myocardial scintigraphy showed no ischemia. Another patient showed moderate reduction in the caliber of a distal *in situ* LITA, used for sequential anastomosis for two LM branches, and obstructive lesion of the last LM branch was slight; it has not been demonstrated ischemia on myocardial scintigraphy. In two patients the graft of the saphenous vein to branches of the RC were occluded, in one patient this coronary artery was already occluded and had collateral filling through AIB, and in the other patient the obstructive lesion was mild according to angiography (50%); CT angiography also showed mild obstructive lesion; there was no ischemia on myocardial scintigraphy and we chose for clinical treatment. Figure 3 shows images of coronary CT angiography and Figure 4 shows images of CT angiography as for positioning of RITA in relation to the sternum.

DISCUSSION

Currently, the evidence is very clear in showing the superiority in the use of both ITAs in CABG surgery. Even so, this surgery is not yet routinely used in major centers around the world. It is known that the use of both ITAs increases surgical time and requires more refined technique, beyond the fear of the risk of sternal infection or severe bleeding; so, there are still doubts and controversies regarding the best surgical strategy. Thus, the use of both ITAs is still not routinely performed in all services and in all subgroups of patients. As a consequence, the utilization rates of ITAs ranges from 4% to 30%, even in countries like USA, Japan and some of Europe[12].

Some studies have shown the use of anteroaortic RITA for AIB with results similar to the LITA, finding 97.2% patency of the LITA for AIB and 96% of the RITA for that same coronary, with follow-up of 80 months[13].

This technique allows the entire left coronary system is revascularized with independent sources of blood supply, using both ITAs *in situ*, or that is, RITA for AIB territory and LITA for CX territory. There is also the option to use the retro-RITA, however, in this technique, when CABG is performed without CPB, this anastomosis is hampered by the need to draw the heart, distancing the coronary from the graft. On the other hand, in anteroaortic position this mentioned difficulty does not occurs, however, a limitation to the

Deininger MO, et al. - Comparative analysis of the patency of the internal thoracic artery in the CABG of left anterior descending artery: 6-month postoperative coronary CT angiography evaluation

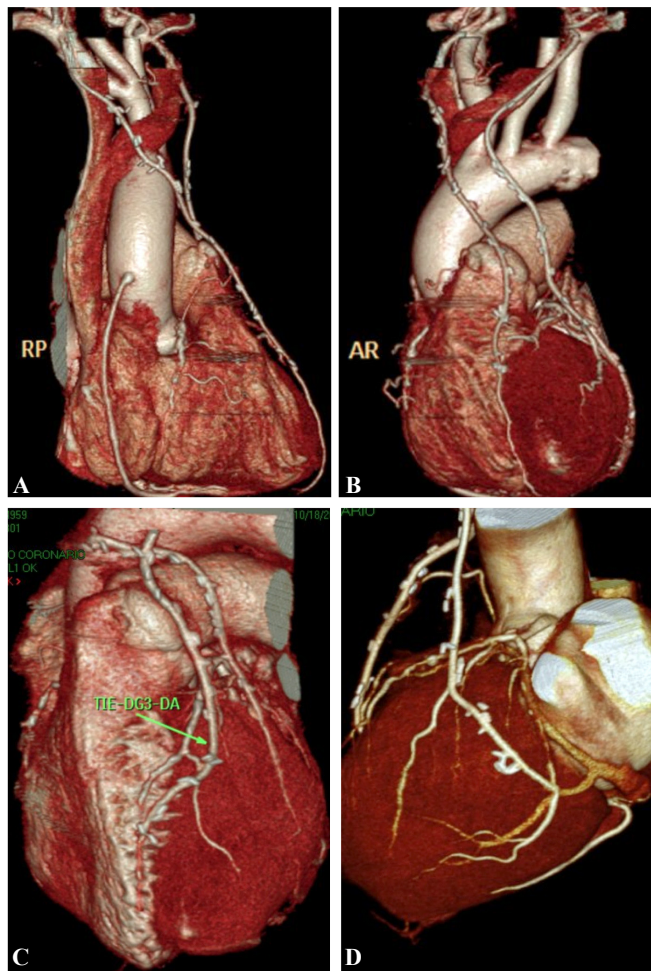*Rev Bras Cir Cardiovasc 2014;29(2):192-201*

Fig. 3 - (A and B) Coronary CT angiography showing positioning of the right internal thoracic artery (RITA) in the cranial portion of the ascending aorta, anastomosed to the anterior interventricular branch (AIB). C) Left internal thoracic artery (LITA) anastomosed to AIB/ diagonal (sequential) and RITA (free) to the left marginal (LM). D) LITA (in situ) anastomosed in diagonals/LM (sequential)

Fig. 4 - (A, B, C and D) - CT angiography showing the positioning of the right internal thoracic artery showing its distance from the sternum

use of this technique is the crossing of the mediastinum by RITA and may lead to graft injury in the event of a reoperation. Some authors, concerned about the possibility of injury to the graft advocated the use of PTFE tube or patch of pedicled thymic fat, all with the aim to protect the RITA when crossing the mediastinum[4,14]. But there are no prospective randomized studies, to assess the patency of both internal thoracic arteries (ITAs) for AIB.

Another limitation to the use of the RITA to the anterior region of the heart is the difficulty to achieve the desired anastomosis site, in the event of the need for distal anastomosis. When we use the skeletonized ITA the length of this artery increases against the pedicle artery, thus allowing the
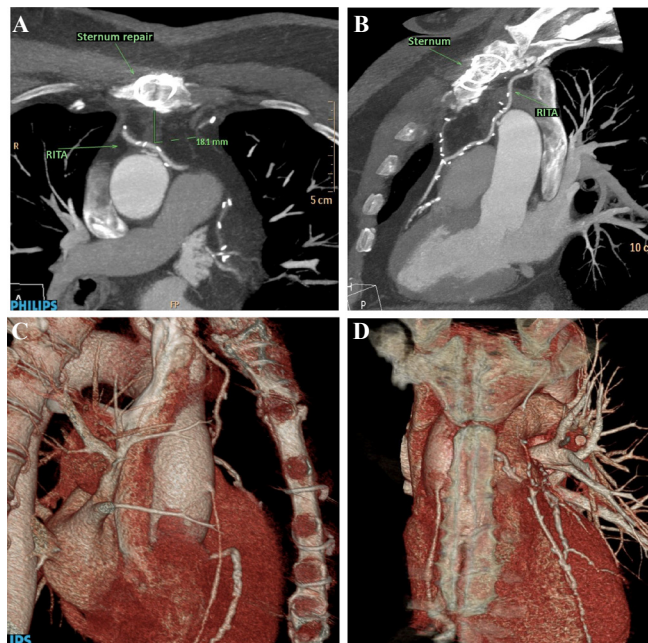
RITA reach the AIB (20.1 vs. 16.4 cm, *P*<0.001.); Besides the reduction in infectious complications in diabetic patients sternum (2.2% vs. 10.0%, *P*<0.05)[15]. The reduction in the risk of sternal osteomyelitis with this technique is due to the preservation of the blood supply and lymphatic drainage, in addition to lead to increased flow compared to the non-skeletonized ITA[16].

Some authors observed that the long-term benefit can be obtained when both ITAs are used for entering the EC territory[17]. The other option for using both *in situ* ITAs to the left coronary system is the retroaortic RITA[3,18]. However, other authors cite limitations in using this technique such as: the length cannot reach two or three LM branches for sequential anastomosis, especially in off-pump surgery; the course of retroaortic RITA may present some disadvantages, such as difficulty in controlling any bleeding of any branch or aortic artery compression or kinks not detected[19].

In the analysis of the primary endpoint, comparing the patency of ITAs in anastomosis for AIB in CABG, all used *in situ*, they were patent by angiography evaluation. In the analysis of secondary endpoints there were no deaths in both groups, and no need for surgical or percutaneous intervention, nor any permanent neurological complications.

In G-1, the ITAs used as a free graft with proximal anastomosis in the ascending aorta, presented a patency rate of

Deininger MO, et al. - Comparative analysis of the patency of the internal thoracic artery in the CABG of left anterior descending artery: 6-month postoperative coronary CT angiography evaluation

Rev Bras Cir Cardiovasc 2014;29(2):192-201

93.18% (41/44). This result is comparable with the literature showing a lower permeability in this technique when compared to the *in situ* graft[20].

In G-2, LITA, that was used for the CX territory presented a patency rate of 94.2% (49/52). In all patients in whom LITA was used for the CX territory and that showed occlusion or stenotic lesion were associated with mild obstructive coronary lesion or no lesion in this method of analysis. It is noteworthy that these patients had coronary angiography in stenotic lesions > 70%, an inclusion criterion in the study.

Some authors assessed the remodeling of ITA and found that the predictors of occlusion are: quality of distal coronary bed, calibrous accessory branches leading to the theft of flow and native flow through the coronary bed; and it may be the reason for the result found by angiography in patients who received the LITA to the CX territory [21]. The best results, when using both ITAs, are obtained when they are used *in situ* for the LC territory, preferably in significant obstructive lesions or occluded arteries. Patency is determined not only by the nature of the biology of graft but also by the flow competition and the degree of stenosis of the coronary territory and the deterioration of the graft is related to obstructive lesion of the coronary branch when it is less than 75%[22].

Venous grafts used for the RC territory showed a patency of 90% and 93.5% in the G-1 and G-2 respectively. The saphenous vein when used for the RC territory features many satisfactory results, comparable to ATI used to that region of the heart.

None of the patients in both groups had high troponin I levels above the established as the cutoff point, or electrocardiographic changes suggestive of a perioperative MI. The on-pump surgery leads to less cell injury compared with the conventional method of CABG surgery, and normal blood troponin level is not certain clue of patent grafts. The opposite is also true, or that is, high levels do not necessarily indicate that the graft is occluded, but only that there was a significant myocardial injury during or after the procedure[23].

The need for blood products was small, when the patient presented bleeding above the expected, we seek to intervene as early as possible to reduce the need for blood products as well as hemodynamic instability. Delayed indication for surgical reexploration for more than 12 hours, implies greater blood loss, with consequent increased need for blood products, in addition to higher mortality and higher incidence of renal and neurological complications and longer hospitalization in the ICU and hospital.

BMI was very similar in both groups. Some authors report no use of both ITAs in obese women and in patients with BMI ≥ 30 due to the high risk of sternal osteomyelitis[24]. On the other hand, others do not consider obesity as an independent risk factor for sternal complications[25].

In several patients we performed four arterial anastomo-

sis to the LC territory, which was possible thanks to the sequential anastomosis by using both ITAs. This shows that through good surgical strategy it is possible to perform a full OPCAB using both ITAs.

CONCLUSION

Coronary artery bypass grafting using antegrade *in situ* RITA for AIB territory, when compared to the *in situ* LITA, anastomosed in the same region, presents the same results in an evaluation period of 6 months, as assessed by angiography coronary with multislice 64 channels, with results showing 100% grafts' patency.

The OPCAB surgery with use of both ITAs for LC territory proved to be safe, effective and feasible, even in patients with multivessel disease, with no deaths in an observation period of 6 months.

Authors' roles & responsibilities	
MOD	Main Author
LFPM	Coauthor
LAOD	Coauthor
OGO	Coauthor
DMSM	Coauthor
JRMC	Coauthor
EGD	Coauthor
NSL	Coauthor
RWQ	Coauthor
EFB	Coauthor

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Rev Bras Cir Cardiovasc 2014;29(2):192-201

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