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Chapter 5

Coronary Artery Bypass Grafting Without Cardiopulmonary Bypass and Without Aortic Manipulation

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Additional information is available at the end of the chapter

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1. Introduction

The methods for coronary artery bypass grafting (CABG) have evolved rapidly in recent years. Procedures such as the CABG without cardiopulmonary bypass (CPB), non-handling of the ascending aorta (AA) and the search for better grafts are strategies that aim at reducing the morbidity and mortality in the immediate postoperative period, the reduction of hospital stay and the increase in expectation and quality of life of patients on long-term [1].

It is known that changes, especially at the cellular level, resulting from the blood flow by non-endothelial surfaces in cardiopulmonary bypass (CPB), trigger the systemic inflammatory response syndrome [2, 3]. The use of CPB, and inflammatory disorders, can cause coagulation disorders with procoagulant effects and may cause early obstruction of the grafts [4], cerebral embolic events with irreversible neurological damage [5-8], and susceptibility to infectious processes due to immune depression in postoperative period [9].

The handling of AA is intrinsically related to the occurrence of cerebrovascular accident (stroke), especially in elderly patients, either at the time of cannulation, clamping and un-clamping of the aorta to the installation and maintenance of the CPB circuit, to carry out the proximal anastomosis of vascular grafts [10-12]. Some studies show that the handling of AA is not the most important factor in reducing neurological complications [13, 14].

Another important factor for the improvement of CABG in the long term is the selection of the grafts and the configuration thereof. It should be taken into account the specific anatomical

and clinical conditions of each patient and the surgical team's experience in obtaining, preparation and anastomosis of the grafts.

The use of composite graft setting in "Y", the left internal thoracic artery (LITA) with arterial segments or segments of great saphenous vein (GSV) to revascularize both the left coronary system (LCS) as the right is a technique widely described in literature, especially in patients at high risk of stroke [15]. This procedure can be performed without CPB and without manipulation of the AA, being the LITA the main source of blood supply to more than one coronary artery. The LITA, in turn can also be used sequentially to the grafting of two or three arteries of the left anterior descending artery (AD), being able to provide adequate blood supply for the entire LCS, both at rest and stress [16].

Although the use of the GSV as aortocoronary graft is related to higher incidence of obstructions than arterial grafts, especially the LITA, in short, medium and long-term disease called aorto-coronary vein graft [17], it seems likely that the use valveless GSV segments in combination with the LITA may modify these results [18, 19]. In our department we use routinely a composite graft of LIMA and valveless GSV, in "Y" for the revascularization of arteries of the LCS.

2. Surgical technique for CABG without CPB and without AA manipulation using composite graft

After electrocardiographic monitoring of central venous pressure and mean arterial pressure, the patient is anesthetized. Proceeding to the opening of the chest (sternotomy or left thoracotomy), exposing finally the heart, the pericardium by setting the drapes. The LITA is completely dissected from its origin until the seventh intercostal space, making up ligation of all branches possible with a metal clip. Obtaining the saphenous vein graft is done preferentially by endoscopic dissection [20]. The procedure is anticoagulation by intravenous administration of sodium heparin at doses of 1.0 mg / kg body weight, with accurate control of the activated clotting time, which must be greater than 200 seconds [21]. We emphasize that both the perfusionist as all the equipment for immediate installation of the CPB circuit is available to the surgical team.

Being the grafts properly prepared, the coronary arteries to be grafted are dissected. The interruption of blood flow to regions of the coronary arteries, where anastomosis shall be made is performed by passing a 5-0 polypropylene line, in eight, with tourniquets proximal and distal to the anastomosis site. Among the coronary and tourniquets, in order to protect the coronary arterial bed, it is interposed a small segment (1.0 cm) of silicone tubes (Figure 1). The intracoronary perfusates are only used in special situations.

The coronary artery is incised longitudinally, and anastomosis performed with the aid of a tissue stabilizer (Figure 1), using a single polypropylene line 7-0 or 8-0 in cases of venous grafts and 8-0 in the case of arterial grafts. Invariably, the LITA is anastomosed to the AD, and one segment GSV, originating from the side of the LITA, revascularizes a second branch of the LCS

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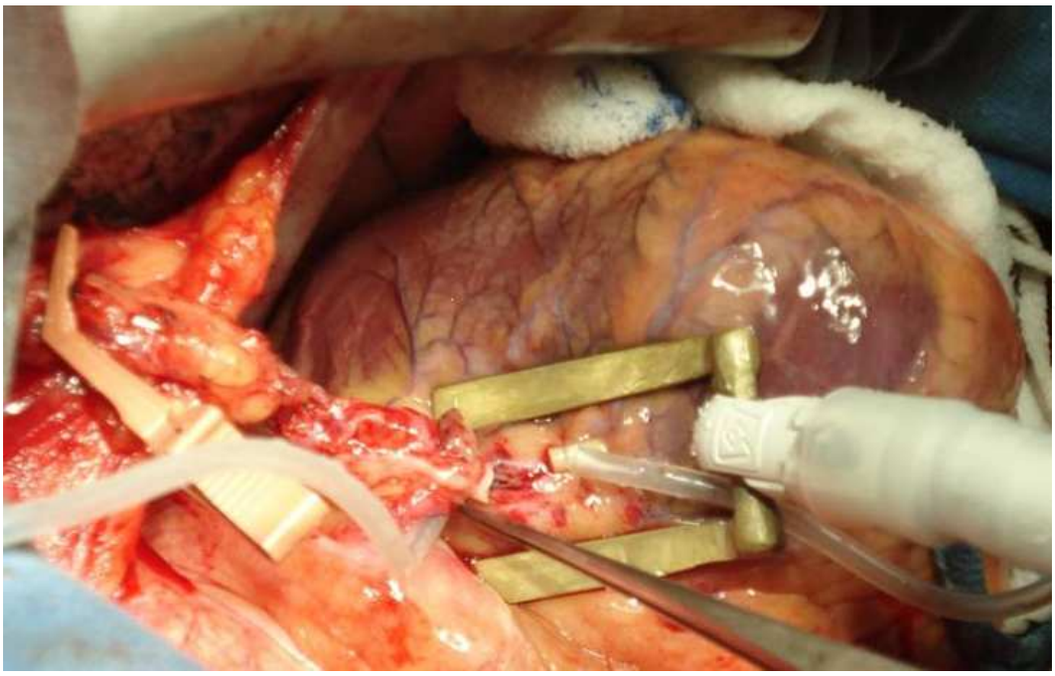

Figure 1. Protection of the coronary arterial bed with a small silicone tube segment number 10 on the occasion of the coronary tourniquet. Device for stabilizing tissue in the anastomosis.

(Figures 2 and 3). For revascularization of the posterior arteries, we used the Lima Point, which facilitates the rotation of the mediastinum to the right [22].

Figure 2. Schematic of a composite graft of LITA with GSV revascularizing the AD and a marginal circumflex artery, respectively

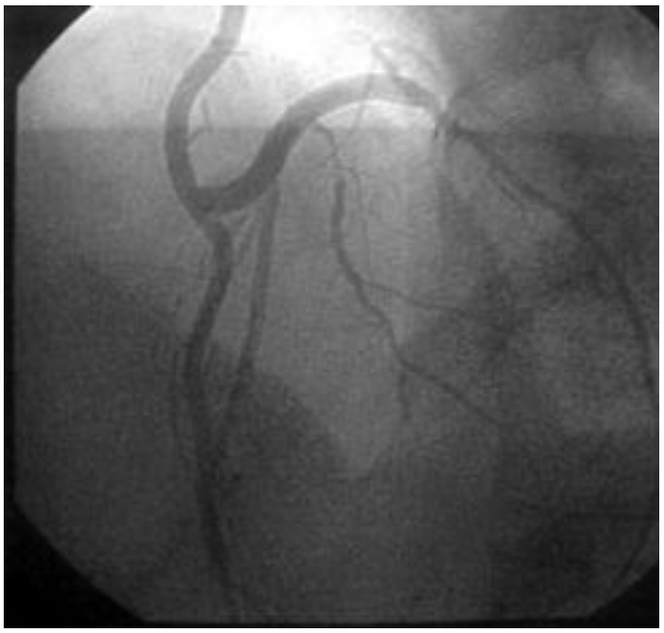

Figure 3. Angiographic study of a composite graft of LITA revascularizing AD and one segment GSV originated from a LITA revascularizing the circumflex marginal artery. Left anterior oblique cranial flow.

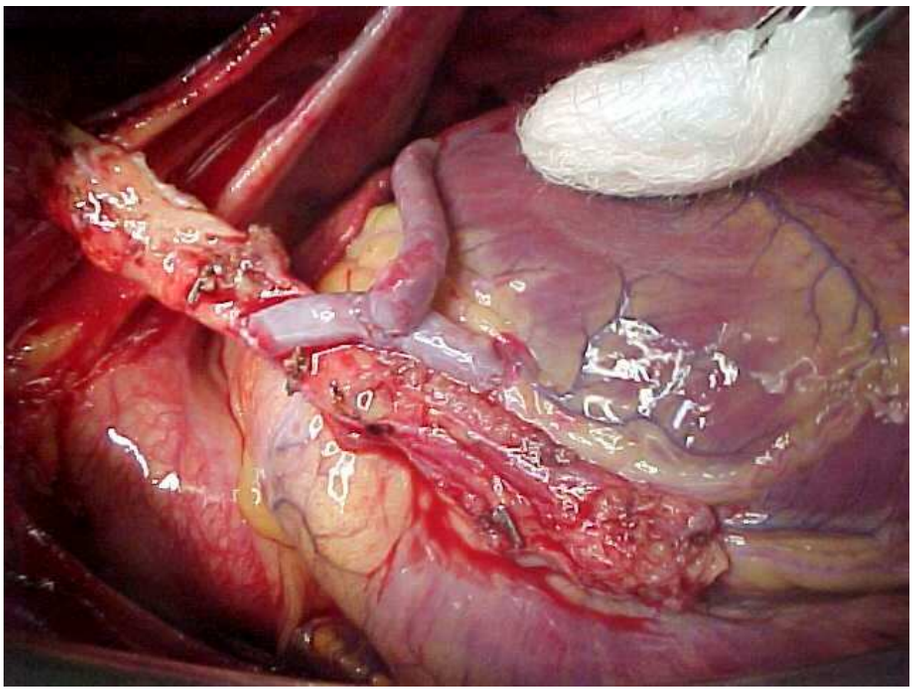

Figure 4. Schematic of a composite graft of LITA revascularizing AD and a GSV segment derived from the LITA revascularizing the 1st Diagonal and a second segment originating from GSV revascularizing a diagonal of the circumflex marginal artery.

When other branches need to be revascularized, a second vein segment stems from the anterior side of the vein segment (Figures 4 and 5). The venous segment can also be anastomosed

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sequentially. The evaluation of the flow of the grafts after preparing the same, using flowmetry instruments is of paramount importance, being routinely performed in various facilities.

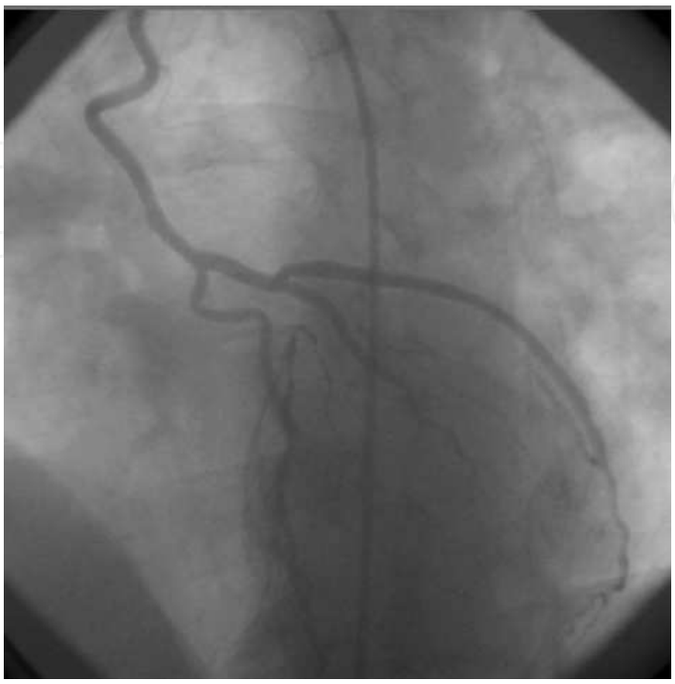

Figure 5. Angiography of a composite graft of LITA revascularizing AD and a GSV segment derived from the LITA revascularizing the 1st Diagonal and a second segment originating from the GSV revascularizing a diagonal of the circumflex marginal artery. Examination 11 years after surgery.

3. Final considerations

In our department, since the mid-1990s, is routinely performed Off Pump Coronary artery Bypass (OPCAB) surgery in 92% of patients with stable coronary artery disease. This associated with the frequent use of LITA grafts composed of GSV and arteries for revascularization of the LCS, with excellent results in terms of morbidity and Doppler or angiographic evaluation of grafts in the short, medium and long term [23-25].

In the preoperative approach of patients we considered critically important the nutritional and medicinal aspects. The reduction of sodium intake and calorie foods, weight loss, regarding the increase of food of real nutrition and immunomodulator value are important. The administration of statins, acetylsalicylic acid (ASA), beta-blockers is maintained until the day before surgery, because they are related to the reduction of inflammatory response, lower incidence of early thrombosis of grafts and prevention of atrial fibrillation in the post- surgery. Glycemic control is done strictly to prevent infectious complications [26].

Regarding the preoperative examinations all patients underwent echocardiography, Doppler study by the carotid and vertebral arteries and the venous system of lower limbs and abdominal ultrasound evaluation, for abdominal aortic aneurysm screening.

Regarding the operative aspects, we think the two biggest factors that increase morbidity and mortality in CABG surgery is the use of CPB and the handling of AA. The CPB, as has been explained, is related to inflammatory changes that may result in exacerbated systemic inflammatory response syndrome affecting multiple organic. Studies clearly demonstrate the association of CPB with brain [27], lung [28], kidney [29] and gastrointestinal [30] damage.

The CPB is still associated with higher levels of bleeding during and after surgery and therefore with greater administration of blood products [31]. The use of these agents in turn, its associated, in addition to the known complications of immunologic and infectious nature, to the lower long-term survival [32]. Another important fact is that in OPCAB the dose of heparin required for anticoagulation is small enough to achieve an activated clotting time greater than 200 seconds, thus the dose of protamine administered at the end of the procedure will be lower, because this drug is related to a series of negative effects on the hemodynamic and inflammatory aspect [33].

The handling of AA, as well discussed, is intrinsically linked to embolic events when there is atheromatous disease of the ascending aorta. However, beyond this fact, the partial or total clamping of the aorta can cause aortic dissection [34].

In an era when one seeks a broader use of arterial grafts one might ask why the routine use of GSV associated with LITA. First one must take into account the morbidity associated with obtaining the grafts. Mediastinitis is a terrible complication associated with increased mortality, with devastating consequences to the physical and psychological integrity of the patient as well as repercussions in terms of financial cost on the public or private health system [35]. The use of two LITAs doubles the risk of internal thoracic mediastinitis compared to the use of a single LITA [36] and can increase up to fourteen times the risk of this complication associated with diabetes mellitus [37].

Regarding the use of the radial artery it is described that its dissection causes neurological complications in about 30 percent of patients [38]. The radial artery is an artery muscle spasm and susceptible to atrophy, especially when used to revascularize the coronary arteries without severe stenosis [39, 40]. It is noteworthy that the angiographic results of radial artery grafts are not superior to that of GSV grafts [41]. Obtaining gastroepiploic artery, in turn, brings the disadvantage of opening of the peritoneal cavity, and similarly to the radial artery, it is prone to spasm and thus it is only used for the revascularization of severe stenosed arteries [42].

Obtaining the GSV causes minimal morbidity, especially when done in an endoscopic manner. It is a long graft, easy to handle and has no tendency to spasm. We consider of utmost importance the venous Doppler study of lower limb in order to ascertain the GSV along its entire length, the presence of valves and varicosities, and mark its location to better perform the incisions for the dissection, with less tissue trauma and preservation of cosmetic and finally the possibility of the preoperative preparation of another option, in those patients in which GSV is not considered appropriate [43].

The obstruction of the GSV grafts occurs mainly by the action of three factors, which are thrombosis, intimal hyperplasia and atherosclerosis [4, 44]. We think that the saphenous vein,

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the way we use it, can have a better behavior than those currently described, for the following reasons:

1. The CABG procedure performed without CPB and, especially in the presence of AAS, has a lower prothrombotic nature, which should be associated with lower rates of occlusion of graft thrombosis [45].

2. The SV segments that we use are small and without valves, reducing the resistance to blood flow and eliminating sites (valves) that favor the development of stenosis [4, 18, 46];

3. Lower blood pressure and circulatory stress imposed on segments of the saphenous vein from the LITA, compared to those originating from the aorta, might cause less damage to the intimate, less development of intimal hyperplasia and atherosclerosis [47, 48];

4. As the endothelium of the LITA is a major producer of nitric oxide, we believe that the SV graft, originating from this artery, may receive part of this hormone, thereby decreasing the incidence of atherosclerotic disease [44, 49];

5. hemodynamically the presence of the valve in the GSV segment can primarily cause entrapment of blood between the coronary anastomosis and the valve due to the phenomenon of flow, natural in the blood circulatory system, with increasing pressure during diastole with consequent stagnation of flow in venous segment; secondarily this flow stagnation limits the infusion, in order to generate a vicious cycle, leading to obstruction of the graft. This mechanism becomes responsible for 20% of cases of graft failure following a year [18, 46].

In order to reduce the heart rate and decrease the energy consumption of the cardiomyocyte during anastomoses, especially of the LITA to the AD, we administered esmolol, beta-blocker of quick action, which has duration of action of about nine minutes. We believe that the use of this drug to integrates the concept of myocardial protection in CABG surgery without CPB [50].

The increasing popularity of off-pump CABG surgery has brought concern, especially in groups that start in the use of this technique, with the quality of anastomoses. Methods for verification of graft patency in the intraoperative period are not commonly performed, and most cardiovascular surgeons rely on electrocardiographic criteria, and hemodynamic enzyme to make a diagnosis of early occlusion of grafts. The use of Transit-time flowmetry has been adopted in many centers for CABG surgery with or without CPB [51].

In cases of elective surgery, epidural anesthesia with opioids and local anesthetic is routinely performed. This procedure has a number of benefits beyond the appropriate component of postoperative analgesia, such as increasing the diameter of epicardial arteries, improves flow through collateral circulation, reduction of myocardial oxygen demand, decreased arrhythmias, lower rates of sternum infection and modulation of inflammatory activity [52, 53].

For the future we aim to allow our patients the benefits of revascularization by left minithoracotomy with the aid of thoracoscopy [54] for cases of revascularization of arteries of the LCS with or without percutaneous treatment of lesions of the right coronary artery or other vessels [55]. We are still attentive to the evolution of epicardial ablation treatment for atrial fibrillation

[56], as well as the development of efficient devices to exclude the left atrial appendage, focus formation and embolization of 60-91%% of thrombi causing embolic ischemic stroke in validity of this tachyarrhythmia [57].

Finally, we believe that surgical revascularization of the LCS can be systematically performed without CPB and without manipulation of the AA, in order to reduce the systemic inflammatory response, blood transfusion, and mortality, particularly related to neurological complications. Furthermore, the use of a valveless GSV grafts associated with LITA for coronary artery bypass grafting of the LCS simplifies the technique of anastomosis "Y", making it more physiological and, it may also be associated with a higher rate of graft patency in the long term.

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