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Vineberg Procedure by "Vineberg Technique modified by Lobo Filho": morbidity and mortality in the imediate post operative period, angiography results and flow analyze of the left internal thoracic artery implanted

Procedimento de Vineberg pela técnica de "Vineberg modificada por Lobo Filho": morbi-mortalidade imediata, resultados angiográficos e análise do fluxo na artéria torácica interna esquerda implantada

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Abstract

Background: **The Vineberg procedure consists in inserting the internal thoracic artery in the ischemic left ventricle muscle. The main question is the ability of this artery to supply adequate flow for the isquemic miocardium.**

Objectives: **To evaluate angiographic results of Vineberg procedure by the Vineberg technique modified by Lobo Filho, the morbidity and mortality in the imediate post operative period (POP) and analysis of the flow of the implanted left internal thoracic artery (LITA) at rest and under stress.**

Method: **Between September 1999 and April 2002, in our service, eight patients were operated by the above describe technique, in which the implant of the internal thoracic artery in the intimacy of the left ventricle muscle is achieved using a kit used for the introduction of the endocardial leads of pacemakers through the subclavian vein. After six months, they went to angiographic and doppler evaluation. For the LITA study with the doppler we divided the sample into two groups: "Vineberg group", formed by the eigth patients mentioned above; and "control group" formed by 20 patients in whom the LITA recascularize directly the anterior interventricular artery. The angiographic study demonstrade patency of all the grafts in both groups. With the doppler, it was measured the output and flow velocity in the grafts. The analysis of data obtained was taken with T-test for paired and unpaired samples.**

Results: **There were no deaths or complications in imediate POP. The angiographic study showed 100% patency. The total output of Vineberg group was 55% of the ones in the Control group. In both groups, the total output increased with the stress.**

Conclusions: **The Vineberg technique modified by Lobo Filho can be used with low rates of morbidity and mortality, high index of patency providing a significant blood flow at rest and under stress.**

Descriptors: **Myocardial revascularization, methods. Left internal thoracic artery, surgery. Echocardiography doppler.**

Resumo

Introdução: **O procedimento de Vineberg consiste no implante da artéria torácica interna na musculatura isquêmica do ventrículo esquerdo. O principal questionamento acerca desse procedimento é a capacidade**

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de fornecimento de fluxo sanguíneo adequado para o miocárdio isquêmico.

Objetivos: **Avaliar os resultados angiográficos do procedimento de Vineberg pela técnica de Vineberg modificada por Lobo Filho e a morbi-mortalidade no pós-operatório imediato (POI), bem como analisar o fluxo na artéria torácica interna esquerda (ATIE) implantada, em repouso e estresse.**

Método: **De setembro de 1999 a abril 2002, em nosso serviço, oito pacientes foram operados pela técnica supracitada, na qual a introdução da artéria torácica interna na intimidade da musculatura do ventrículo esquerdo foi realizada com auxílio de um "kit" destinado à introdução de marcapassos cardíacos endocárdicos definitivos por punção da veia subclávia. Após seis meses, os pacientes foram estudados angiograficamente e submetidos ao ecodoppler da ATIE implantada. Para estudo do fluxo da ATIE pelo ecodoppler, constituímos dois grupos: "Grupo Vineberg", composto pelos oito pacientes citados; e o "Grupo Controle", composto por vinte pacientes, nos quais a ATIE foi utilizada para revascularizar diretamente a artéria interventricular anterior. O estudo angiográfico demonstrou perviabilidade de todos os enxertos em ambos os grupos. No estudo pelo ecodoppler, foram realizadas medidas de débito e velocidade de fluxo no enxerto. A análise dos dados obtidos foi feita pelo teste-T para amostras pareadas e não pareadas.**

Resultados: **Não houve óbitos ou complicações no POI. O estudo angiográfico demonstrou perviabilidade em 100% dos casos. O débito total observado foi cerca de 55% daquele encontrado no Grupo Controle. Em ambos os grupos, o débito total aumentou do repouso para o estresse.**

Conclusão: **A técnica de Vineberg modificada por Lobo Filho pode ser utilizada com baixas taxas de morbi-mortalidade, alto índice de perviabilidade, oferecendo fluxo sanguíneo significativo em repouso e sob estresse.**

Descritores: **Revascularização miocárdica, métodos. Artéria torácica interna esquerda, cirurgia. Ecocardiografia doppler.**

INTRODUCTION

In 1933 Wearn et al. [1] demonstrated the existence of a rich network of myocardial sinusoids which anastomised among themselves, to the capillary vessels and directly to the ventricular lumen. Starting from this knowledge, the Canadian surgeon Arthur Martin Vineberg [2-5] proposed, in the middle of the 1940s, the indirect myocardial revascularization surgery. This consisted of the implantation of the internal thoracic artery (ITA) without legation of its branches, directly into the left ventricle musculature. It was believed that the ITA could revert cardiac muscle ischemia, by the development of collateral links with the myocardial sinusoids and with the obstructed coronary arteries.

Despite of the clinical benefits described by Vineberg, anatomical proof of the efficiency of his technique could only be demonstrated at the start of the 1960s with the development of coronary angiography by Sones & Shirey [6]. These authors demonstrated that there was a communication between the ITA graft and the coronary arteries [6,7]. From then on, several centers began to adopt this surgical procedure and to reproduce the angiographic results demonstrated by Sones & Vineberg [8-10]. Although it was a controversial technique, it was the first surgical procedure for the treatment of coronary failure, which was scientifically proven as recent works demonstrate [11-13].

Aiming to develop a less invasive technique with a lower morbid-mortality rate, Lobo Filho proposed a variation of the original technique described by Vineberg. This new technique, called the Vineberg-Lobo Filho technique, consists of the transplantation of the left internal thoracic artery (LITA) in the free anterior wall of the left ventricle (LV), without the use of cardiopulmonary bypass (CPB) and using a pacemaker lead introducing kit [14].

The Doppler echocardiograph study of the LITA linked by a pedicle to the anterior interventricular artery (AIV) has become more important over the last years as a non-invasive method to evaluate the flow and the permeability of the graft [15-19]. In works published between 1992 and 2001, De Simone et al. [15], Chirillo et al. [20], De Bono et al. [21] and Van Son et al. [22] demonstrated successful detection of the LITA in 100% of the cases.

The Doppler echocardiograph study of the flow in the LITA pedicle anastomised to the AIV points to a difference in the pattern of its flow when compared to the LITA in its non-grafted anatomical position. In this case, the LITA presents with a flow pattern which is predominantly systolic, whilst the LITA anastomosed to the AIV possesses an increase in the diastolic flow, compatible with the flow pattern of the coronary arteries [16,19,23}.

Recent publications present a study of the flow by Doppler echocardiography of the ITA implanted in the myocardial wall. However, these works are limited to case reports [13,24].

We did not find descriptions in the literature of works, which evaluate the flow behavior in the LITA, at rest or under stress, using echocardiography, of a group of patients submitted to the Vineberg procedure, utilizing as a control patients in which the LITA was anastomosed to the AIV.

In this work, we assessed the angiographic results of the LITA implanted using the Vineberg technique modified by Lobo Filho, the morbid-mortality in the immediate post-operative period, as well as an analysis of the flow behavior in the implanted LITA at rest and under pharmacological stress.

METHOD

From September 1999 to April 2002 eight patients underwent operations using the Vineberg technique modified by Lobo Filho in our department. After six months, angiographic and Doppler echocardiographic studies were performed on the implanted LITA. All the surgeries were performed by the same surgical team.

To analyze the flow in the implanted LITA, two groups were formed. The Vineberg group was composed of eight patients of the previously mentioned sample, of which 50% were male. The ages varied from 43 to 67 years with an average of 60.4 ± 8.3 years.

The control group consisted of twenty patients who were submitted to coronary artery bypass grafting (CABG) using the LITA with pedicle only to replace the AIV. Male patients were more predominant (60%). The ages ranged from 38 to 75 years with a mean of 58.3 ± 8.6 years.

Patients who had previously suffered from myocardial infarction were excluded from this study.

The immediate post-operative period was considered to be the first thirty days after operation. To evaluate the morbidity, the following complications were considered: cerebral stroke, mediastinitis, bleeding requiring a reoperation or acute post-operative myocardial infarction.

Surgical technique

After dissection of the LITA using the conventional method with its entire pedicle, approximately seven centimeters of its distal portion are entirely cleaned with sectioning of the intercostal branches at their roots. Compresses are placed on the posterior portion of the pericardial sac in a way that there is a good contact with the anterior face of the LV, without the need of cardiopulmonary bypass (CPB). Using a endocardial pacemaker electrode introducer kit number '10 F' the portion of the LV in which the implantation of the LITA is desired is transfixed with a needle, generally parallel to the AIV. The guide wire is then placed in the position of the needle and connected to the distal portion of the LITA. The guide wire is then drawn, taking with it the LITA inside the fatty sheath, which after its removal leaves the LITA inside the tunnel. Finally the distal portion of the LITA is legated closing the exit orifice in the wall of the LV and securing the pedicle of the artery in the epicardium, close to the entrance orifice in the wall of the LV. We previously described this technique with illustrations and figures, stressing the facility of the procedure, even without the use of CPB [14].

Protocol of the Doppler echocardiography at rest and under stress induced by dobutamine

The doppler echocardiography of the LITA in all patients of both groups was by the same team composed of two specialists in echocardiography. With the patients in the dorsal recumbent position, the LITA in the region of the left super-clavicular fossa was visualized, utilizing ATL or the Vingmed System Five echocardiographs and transducers of 7.5 or 5 MHz.

The same flow parameters were evaluated at rest and under stress. After the evaluation of the flow parameters at rest, the two groups of patients were submitted to the same infusion protocol of dobutamine for stress induction, utilizing progressive doses of 10, 20, 30 and 40 µg/Kg/min, with increases at 3-minute intervals. The examination was concluded when the heart beat (HB) reached a rate of greater than or equal to 85% of the maximum HB admitted for each patient [25].

The flow velocity curve obtained by the Doppler echocardiography of the LITA in a patient under stress in the Vineberg group is demonstrated in figure 1.

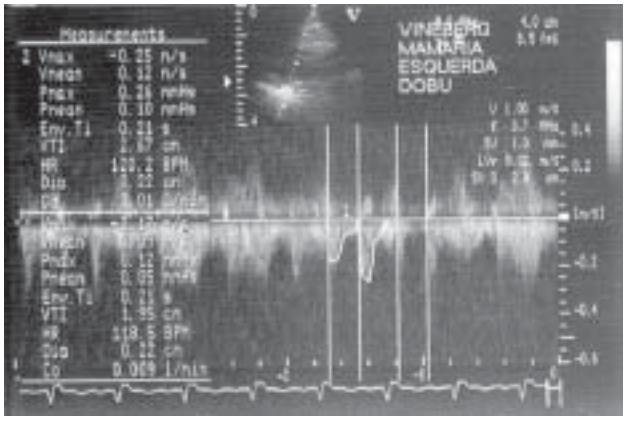

Fig. 1 - Echodoppler study of a left internal thoracic artery implanted in the muscles of the left ventricle. It is possible to see the bi-phase flow standard in the left internal thoracic artery.

Studied flow parameters with the objective of analyzing the behavior of the flow in the implanted LITA:

Systolic outflow in mL/min (SO)

Diastolic outflow in mL/min (DO)

Total outflow in mL/min (TO): calculated by summing SO and DO

Ratio between the total outflow under stress and the total outflow at rest (STO/RTO).

Statistical analysis

Statistical analysis of the flow parameters obtained at rest and under stress within the same group was made using T-test for paired samples, whilst statistical analysis of the flow parameters obtained at rest and under stress in the

different groups was achieved using T-test for non-matched samples. Welch correction was utilized in the T-test for non-matched samples in cases in which the variances between the groups were different. A p-value < 0.05 was considered statistically significant.

RESULTS

There were no deaths or complications in the immediate post-operative period. All the patients submitted to angiography presented with permeability of the implanted LITA graft (Figures 2 and 3).

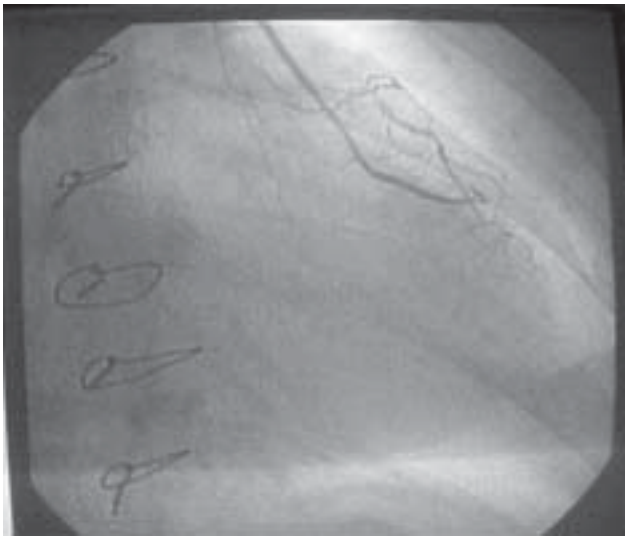

Fig. 2 - Angiographic study of a left internal thoracic artery implanted in the muscle of the left ventricle. Observe the collateral circulation between the left internal thoracic artery, the anterior interventricular and septal arteries.

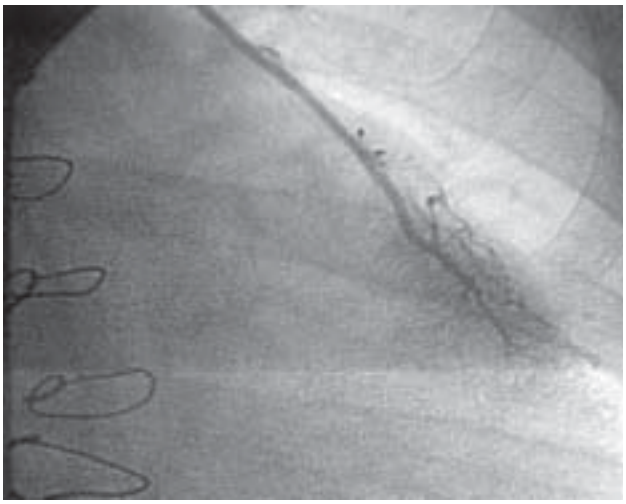

Fig. 3 - Angiographic study of a left internal thoracic artery implanted in the muscle of the left ventricle. Observe the formation of collateral circulation with the myocardial sinusoids.

Analysis of the LITA flow – Vineberg Group.

The SO increased, from rest to stress, from 10.1 ± 4.3 mL/min to 16.0 ± 7.5 mL/min, corresponding to an increase of 58.4% (p-value > 0.05). The DO increased from rest to stress, from 14.1 ± 9.0 mL/min to 23.3 ± 13.2 mL/min corresponding to an increase of 64.5% (p-value < 0.05). The TO increased from 24.3 ± 12.1 mL/min to 39.3 ± 16.1 mL/min, corresponding to an increase 61.8% with a p-value < 0.05 (Figure 4). The ratio STO/RTO was 1.52 ± 0.72. The mean TO values at rest and under stress of the Vineberg group are shown in Figure 4.

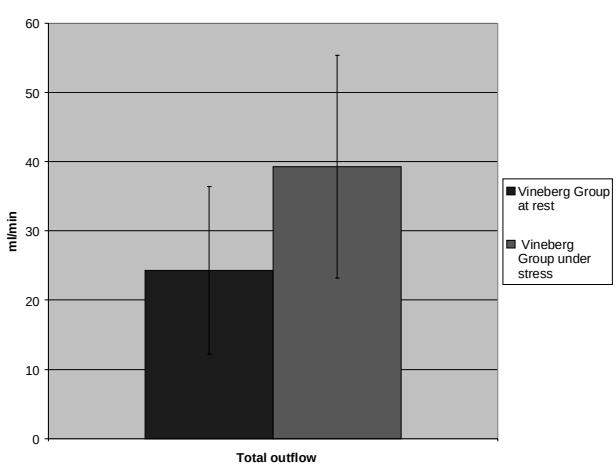

Fig. 4 - Mean total outflow values at rest and under stress of the Vineberg group. Increase of 61.8% (24.3 ± 12.1 ml/min versus 39.3 ± 16.1 ml/min; p<0.05).

Analysis of the LITA flow – Control Group.

The SO increased from rest to stress from 19.0 ± 10.2 mL/min to 19.5 ± 18.8 mL/min, corresponding to an increase of 2.6% (p-value > 0.05). The DO increased from rest to stress from 26.4 ± 13.6 mL/min to 49.3 ± 19.9 mL/min corresponding to an increase of 86.9% (p-value < 0.001). The TO increased from 45.5 ± 21.6 mL/min to 68.3 ± 32.9 mL/min, corresponding to an increase of 50.2% (p-value < 0.001). The ratio STO/RTO was 1.60 ± 0.57.

The values of all the parameters analyzed, from both groups at rest and under stress are demonstrated in Tables 1 and 2.

The mean values of the outflows of both groups both at rest and under stress are shown in Figure 5.

Analysis between the groups

At rest the SO, DO and TO in the control group were greater than those of the Vineberg group (p-value < 0.05). Under stress these values were also higher in the control group when compared with the Vineberg group, however the difference was not significant for SO.

Table 1. Analysis of the flow parameters in the left internal thoracic artery obtained by echocardiography at rest and under stress of group A (control group) and group B (Vineberg group).

	Control group n = 20		Vineberg group n =8	
PARAMETERS	***At rest***	***Under stress***	***At rest***	***Under stress***
SO (ml/min)	19.0±10.2	19.5±18.8 (NS)	10.1±4.3	16±7.5 (NS)
DO (ml/min)	26.4±13.6	49.3±19.9 [b] (S)	14.1±9.0	23.3±13.2 [a] (S)
TO (ml/min)	45.5±21.6	68.3±32.9 [b] (S)	24.3±12.1	39.3±16.1 [a] (S)
TOS/TOR * [c]	1.60±0.57		1.52±0.72 (NS)	

SO = systolic outflow; DO = diastolic outflow; TO = total outflow; TOS/TOR = Total outflow under stress to total outflow at rest; S = Significant for p<0.05; NS = Not Significant for p<0.05;

* The ratio TOS/TOR was analyzed using the t-test for non-paired samples
[a] p<0.05 ; [b] p<0.001 ; [c] p=0.76

Table 2. Non-paired analysis of the flow in the left internal thoracic artery obtained by echodoppler at rest and under stress between groups A (control group) and B (Vineberg group).

	RESTING		UNDER STRESS	
PARAMETERS	***Vineberg***	***Control***	***Vineberg***	***Control***
SD (ml/min)	10.1±4.3	19.0±10.2 [b] (S)	16±7.5	19.5±18.8 (NS)
DD (ml/min)	14.1±9.0	26.4±13.6 [a] (S)	23.3±13.2	49.3±19.9 [b] (S)
TD (ml/min)	24.3±12.1	45.5±21.6 [a] (S)	39.3±16.1	68.3±32.9 [b] (S)

SD = systolic outflow; DD = diastolic outflow; TD = total outflow; S = Significant for p<0.05; NS = Not Significant for p<0.05;

[a] p<0.05 ; [b] p<0.01

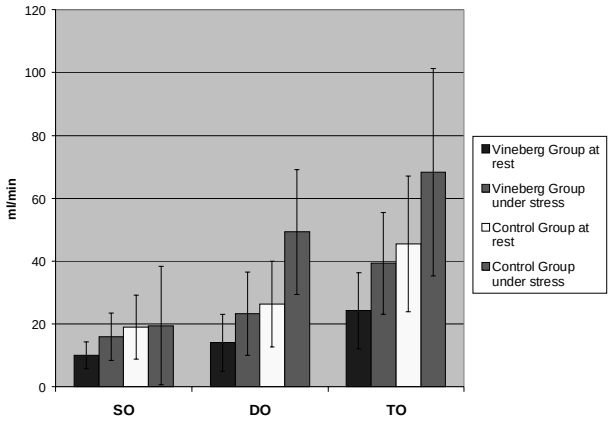

Fig. 5 – Comparison of the mean systolic outflows (SO), diastolic outflows (DO) and total outflows (TO) in ml/min in the Vineberg and control groups at rest and under stress.

The TO at rest in the Vineberg group corresponded to 53.3% of the TO in the control group. The TO under stress of the Vineberg group corresponded to 57.5% of the TO of the control group.

The STO/RTO ratio was similar in both groups.

COMMENTS

Complications following the Vineberg procedure were, mainly, cardiac problems. This is probably due to the maneuvers involved with the implantation of the ITA in the myocardium [26]. Favaloro et al. [26] in an important study involving 614 patients submitted to a single implantation of the LITA in the myocardium, evidenced a morbidity rate of 21.5%. Of these complications, 83.3% were related to the heart and the observed mortality rate was 5.4%.

In a recent publication, Lobo Filho [14] evidenced a morbid-mortality rate of 0% in the immediate post-operative period in a group of 23 patients. We believe that this result is due to the fact that this technique is less traumatic to the musculature of the LV.

In 1963, Vineberg reported that five of eight patients who were submitted to an angiography possessed a pervious LITA graft with collateral links [10]. In the same year, Bigelow et al. [27] reported that five out of five studied were pervious and were linked to coronary arteries. In 1964, Effler et al. [28] reported that 80% of the studied grafts from three to six months after the surgery were functional. In 2001, Lobo Filho [14] observed a permeability rate of 90% in a group of ten patients who were assessed by angiography. Thus, we observed that the LITA implanted using the Vineberg technique modified by Lobo Filho presented with angiographic results similar to those previously published.

In relation to the measurement of the blood flow in the grafted LITA, Kaytz & Suzuki utilized cineangiography to non-invasively measure the flow [10]. In three patients investigated five months after the procedure, these authors found that the flow varied from 11 to 59 mL/min, indicating that the grafted LITA could supply a considerable amount of blood to the ischemic myocardium [10]. Gorlin & Taylor [29], utilizing the clearance of a saline solution with radioactive isotopes, injected in the implants, arrived at a similar conclusion.

However, not all the results of studies of fluxes demonstrated an efficacy of the Vineberg procedure. Dart et al. [30] performed an investigation of the flow in the LITA in humans during a thoracic sympathectomy surgery. A direct measurement of the flow was obtained in thirteen patients previously submitted to the Vineberg procedure. They evidenced a mean flow of 8.2 mL/min

and concluded that the implants offered less than 4% of the total coronary flow. However other authors considered that the patients who require sympathectomy, were probably among the 20% of patients whose implant would be occluded [10]. Additionally, in these patients, the type of graft described by Vineberg would not be used. In these cases, Sewell´s pedicle a structure composed of the LITA, veins and a 1.5-cm layer of endothoracic fascia, pleura and muscle would be used [26, 31, 32].

The Doppler echocardiograph study of the LITA has been considered, over these years, as an important non-invasive method for the evaluation of the permeability and flow of the graft [15-19]. Among the flow parameters investigated by means of echocardiography, the STO/RTO ratio of the grafted LITA is considered by numerous authors as the best form of evaluating the capacity of the graft to offer an adequate blood flow in situations of increased demand, that is, in situations of metabolic stress [33-35].

In our study, the STO/RTO ratio in the Vineberg group was of 1.52 ± 0.72 while in the control group it was 1.60 ± 0.57, a non-significant difference. These results demonstrate that the LITA, when it is implanted near to the musculature of the myocardium, presents with the capacity of increasing its flow in situations of increased demand.Nasu et al. [24], in a case report, also studied the behavior of the flow in the LITA of a patient who, 23 years previously, was submitted to the Vineberg procedure. They observed that the graft presented a capacity to respond to stress, and that the STO/RTO ratio was 1.6, that is, similar to what is described in our study.

Marx et al. [13] performed an echocardiographic study of a lateral implant of the ITA, 27 years after the operation. The LITA had been implanted in the posterolateral wall and the right ITA had been implanted in the anterolateral wall of the LV. A biphasic flow pattern (systolic-diastolic) was observed in both of the grafts, in which the diastolic component represented a marker of coronary perfusion. The authors affirmed that this flow pattern is comparable to the coronary circulation.

However, under stressful conditions, no increase in the flow was detected. In this case, the result was attributed to the terminal stage of coronary artery disease of the patient who, at the time of the operation, had already suffered two anterior and one posterior myocardial infarctions. We believe that the significant reduction of the viable myocardial area was a limiting factor for the increase of flow in the grafts with the induction of stress.

In relation to angiogenesis, one of the justifications for the efficiency of the Vineberg procedure, Pecher & Schumacher [36] published a study demonstrating the induction of angiogenesis in a ischemic human myocardium, a conduct that is increasingly being considered for patients who are not candidates for direct or percutaneous revascularization.

The echocardiographic study demonstrated an increase in the left ventricular ejection fraction in the group in which angiogenic factors were administered when compared with the group in which denatured factors were injected into the myocardium.

In 2001, Johnson et al. [37] published a study that suggested benefits of the Vineberg procedure performed in association with angiogenic therapy. An angiogenic mixture with intramyocardial selante was administered combined with the Vineberg procedure in seven patients, who had arteries which were inadequate for right revascularization or endarterectomy. The long-term follow-up showed extensive vascularization in the treated areas.

There are more and more reports of patients with indications for surgical treatment, which, however, do not present with arteries adequate for revascularization, due to their diffusely calcified presentation or with a greatly reduced caliber [36]. In these cases, the Vineberg procedure can be employed, either associated or not with right revascularization of other arteries in the coronary system, including the posterior arteries, without the use of CPB [38, 39].

In relation to the utilized technique, we can, for teaching purposes, number the main advantages:

1. Speed and simplicity of the procedure [14];
2. Less trauma to the myocardial fibers by the catheter introducer, reducing the possibility of bleeding, infarction and heart failure [14];
3. Increase in 50% (from four to six centimeters) of the grafted LITA section [40];
4. High incidence of permeability of the graft;
5. Easy reproducibility [14].

We believe that the systematization of this new technique will enable the Vineberg procedure can be used more frequently, both in isolation and associated with right revascularization of other coronary arteries. We also believe that, with the development of angiogenic therapy, the Vineberg procedure by the technique mentioned above may be an important co-adjuvant therapy.

CONCLUSION

In conclusion, the Vineberg technique modified by Lobo Filho can be utilized with low rates of morbid-mortality and good rates of permeability. We also

concluded with this procedure, the LITA presented with capacity to adapt from the flow at rest to the flow under stress, with a mean blood supply 55% in relation to that of the LITA anastomosed directly to the AIV.

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