

# Should the diabetics have the internal thoracic artery skeletonized? Assessment of sternal perfusion by scintillography

*Diabéticos devem ter a artéria torácica interna esqueletizada? Avaliação da perfusão esternal por cintilografia*

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## Abstract

**Objective:** To assess, by scintillography, the effect of using bilateral internal thoracic arteries (BITAs) - prepared by two different techniques - on the sternal perfusion.

**Method:** 35 patients undergone coronary artery bypass grafting (CABG) were divided into two groups: Group A (18) had both ITA's dissected using skeletonization technique and group B (17) as pedicle preparation. There was no difference in the two groups relating gender, age and demographic characteristics. On the 7<sup>th</sup> postoperative day the patients underwent bone scintillography. The statistical analysis was performed using the Student's t test with 95% significance.

**Results:** Group A (skeletonized ITA) showed higher perfusion (11.5%) of the sternum as a mean, than Group B (pedicled ITA) patients; however this was not statistically significant ( $P = 0.127$ ). On the other hand, comparing the

diabetic population, seven in each group, there was a marked 47.4% higher perfusion of the sternum in Group A patients (skeletonized ITA) comparing to Group B (pedicled ITA) and this difference reached statistical significance ( $P = 0.004$ ).

**Conclusions:** 1 - Sternal perfusion is not affected significantly apart from the dissection technique used for both internal thoracic arteries in the general population when assessed by bone scintillography. 2 - In the diabetic subgroup, a significant preservation of the sternal perfusion was observed in patients undergone skeletonized dissection of the internal thoracic arteries. Although these findings should be confirmed in a greater number of cases, diabetic patients should have the internal thoracic arteries dissected using skeletonization technique.

**Descriptors:** Sternum. Mammary arteries. Tomography, emission-computed.

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### Resumo

**Objetivo:** Avaliar o impacto na vascularização do esterno, por cintilografia óssea, da utilização de ambas as artérias torácicas internas (ATIs), preparadas por duas técnicas diferentes.

**Métodos:** Trinta e cinco pacientes coronarianos foram divididos em dois grupos: Grupo A - 18 pacientes tiveram as duas ATIs dissecadas de forma esquelizada; Grupo B - 17 pacientes tiveram as duas ATIs dissecadas pela técnica pediculada. Não houve diferença nos dois grupos com relação a gênero, idade e características demográficas. Realizou-se cintilografia óssea 7 dias após a cirurgia. A análise estatística foi realizada utilizando-se o teste de t de Student, com significância estabelecida em 95%.

**Resultados:** No grupo A (ATI esquelizada), o nível de captação do esterno foi de 11,5% mais alto em comparação com a média dos 17 pacientes do grupo B (ATI pediculada), mas essa diferença não foi estatisticamente significante

( $P = 0,127$ ). Entretanto, a média dos níveis de captação do esterno nos sete pacientes diabéticos do Grupo A (ATI esquelizada) foi 47,4% mais alta em comparação à média dos sete pacientes diabéticos do grupo B (ATI pediculada), e esta diferença foi estatisticamente significante ( $P = 0,004$ ).

**Conclusão:** 1 - A forma de dissecação das ATIs não altera de maneira estatisticamente significativa a perfusão esternal, avaliada por cintilografia óssea, no conjunto geral da população estudada. 2 - No subgrupo de pacientes diabéticos, observou-se melhor perfusão do esterno nos pacientes submetidos à dissecação esquelizada. Embora a confirmação desse achado num maior número de casos seja necessária, pacientes diabéticos devem ter as artérias torácicas internas dissecadas de forma esquelizada.

**Descritores:** Esterno. Artéria torácica interna. Tomografia computadorizada de emissão.

## INTRODUCTION

The use of two internal thoracic arteries (ITA) in coronary artery bypass grafting seems to result in better survival and reduced need for late reoperation [1-4]. However, this technique is not yet performed as a current practice, by arguing that the use of ITA would be associated with more morbidity, increased need for hemotransfusion [5], increasing probability of transoperative myocardial infarction [6] and, in particular, sternal osteomyelitis [7-10].

A retrospective study, analyzing a series of 2,594 patients undergoing CABG, showed, among other factors, the use of ITAs as a major risk factor for sternal infection [9]. A prospective, non-randomized study, in a series of 2,356 patients, identified through multivariate analysis, as a risk factor for sternal infection, the use of ITAs in the presence of diabetes mellitus [7].

An anatomic study suggested that the dissection of ITAs could lead to complete devascularization of the sternum [11], which would provide greater incidence of infections, especially in diabetic patients.

The dissection of internal thoracic artery (ITA) in a skeletonized manner, described by Keeley [12] in 1987, consisted of only obtaining the artery, without the adjacent tissues. This proposal aimed at the possible solution to problems associated with the use of ITA, such as low blood flow [13], improper length of the graft [14] and infection of

the sternum [15,16], as observed recently in our country [17].

The study of sternal perfusion after dissection of the ITA, both through a pediculated or skeletonized technique, has already been object of several experimental studies [18,19] and clinical trials through the bone scintigraphy [20-22]. However, some results are conflicting.

The use of bone scintigraphy to assess the perfusion of the sternum was performed initially by purely visual analysis of the uptake of radioactive tracer [20]. After, it was established a quantitative analysis, by comparing the uptake of radioactive tracer by the sternum with another bone structure chosen as reference [23]. Other studies used the same principle for the evaluation of sternal perfusion, but using different methods [21,22,24].

This study was designed to assess the impact on sternal vascularization, by bone scintigraphy, of the use of ITAs dissected by two different techniques: pedicled and skeletonized. The study was performed in coronary patients and those with diabetes mellitus were not excluded.

## METHODS

In the period between June 2005 and July 2006, 566 patients underwent CABG surgery at the Heart Institute of Pernambuco (Real Hospital Português de Beneficência in Pernambuco). Of these, 35 were prospectively selected for this study by establishing the following inclusion criteria:

1. Patients of both genders, aged less than or equal to 18 years with symptoms of stable angina and angiographic diagnosis of obstructions in at least two branches of the left coronary artery with indication for surgical treatment;
2. Patients with severe left ventricular dysfunction;
3. First heart surgery;
4. Patients who did not need associated procedures.

The 35 patients were divided into two groups:

• **Group A:** 18 patients in whom the ITAs were dissected through skeletonized technique. Thirteen (72.2%) patients were male, and five (27.8%) females, aged from 41 to 79 years (mean 56.6%);

• **Group B:** 17 patients in whom the ITAs were dissected by pedicle preparation. Thirteen (76.5%) patients were male and nine (23.5%) females, aged from 33 to 79 years (mean 59%).

Fifteen patients underwent surgery using cardiopulmonary bypass (CPB) and 20 without CPB. The choice of technique was based on clinical indication and the individual surgeon's preference. In group A, the average number of arteries grafted was  $2.6 \pm 0.69$  and in group B was  $2.5 \pm 0.5$ . It was always used ITAs for the branches grafting of the left coronary artery.

### Scintigraphic evaluation

All patients underwent bone scintigraphy seven days after the operation. Planar image was obtained with 1,000,000 counts in the anterior projection of the chest, with sternum, clavicles and low neck, acquired three hours after the intravenous administration of 20mCi of Tc99m-MDP, using a GE MAXXUS gamma camera.

Qualitative and quantitative analysis of the scintigraphic images were performed by an observer without knowledge of clinical data or to which group the patients belonged. The qualitative analysis examined the homogeneity of uptake across the sternum and the uptake symmetry between the right and left halves of the sternum divided by sternotomy (Figures 1A and 1B).

In quantitative analysis, the intensity of tracer uptake was calculated (mean counts per "pixel") in the left and right halves of the manubrium, body and sternal xiphoid process and, in the sternum as a whole, through the delineation of regions of interest (ROI). The intensity of uptake in these regions was compared with the left clavicle (Figure 2).

### Statistical analysis

Statistical analysis was performed using the Student's t test or chi-square, when appropriate, with statistical significance set at 95%.

### Ethical Procedures

The protocol used in this study was approved by the

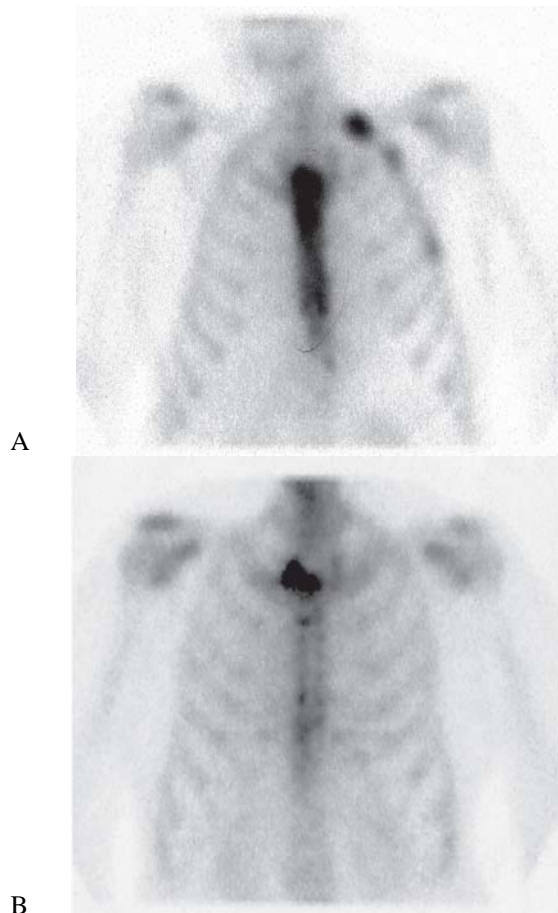


Fig. 1 – Sample of scintillography image assessed on the postoperative period, by noting the patient A with high uptake and, in B, low uptake of the tracer

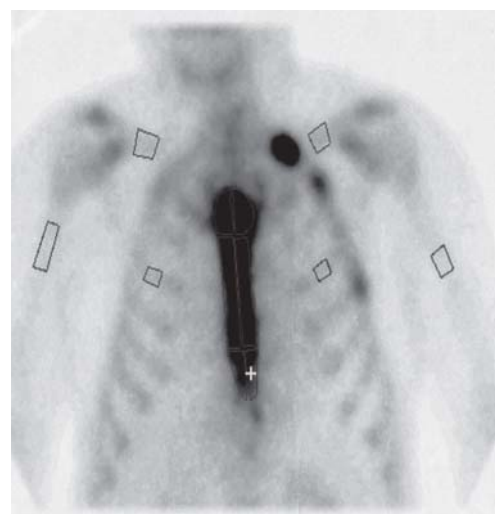


Fig. 2 – Scintillography image with delineation of the regions of interest (ROI), emphasizing the image of the left clavicle as a reference point

Research Ethics Committee of the Center for Health Sciences, Federal University of Pernambuco (No. 094/06). The patients were informed in plain language, that they would participate in a clinical research and signed the written informed consent.

## RESULTS

In a series of the studied cases, there were no deaths or significant postoperative complications, especially sternal infection.

The epidemiological characterization of the groups showed homogeneous distribution of diseases, ventricular function and number of grafted coronary arteries (Table 1).

In group A (skeletonized ITA), the mean of uptake levels of the sternum was 11.5% higher compared to the mean of patients in group B (pedicled ITA). The difference, equal to 0.36, was not statistically significant (Student's t test:  $P=0.127$ , Table 2).

In group A, the mean uptake levels of the manubrium was 11.4% higher compared to the mean of patients in group B. The difference, equal to 0.43, was not statistically significant (Student's t test:  $P=0.168$ , Table 3).

In group A, the mean uptake levels of the body was 14.3% higher compared to the mean of patients in group B. The difference, equal to 0.43, was not statistically significant (Student's t test:  $P=0.119$ , Table 4).

In group A, the mean uptake levels of the xiphoid was 6.9% higher compared to the mean of patients in group B. The difference, equal to 0.16, was not statistically significant (Student's t test:  $P=0.334$ , Table 5).

### Results in diabetic patients

In the seven diabetic patients in group A, the mean uptake levels of the sternum was 47.4% higher compared to the mean of seven diabetic patients in group B. The difference, equal to 1.26, was statistically significant (Student's t test:  $P=0.004$ , Table 6).

In the seven diabetic patients in group A, the mean uptake levels of the manubrium was 45.0% higher compared to the mean of seven diabetic patients in group B. The difference, equal to 1.47 was statistically significant (Student's t test:  $P=0.011$ , Table 7).

In the seven diabetic patients in group A, the mean uptake levels of the body was 63.3%

Table 1. General patient's characterization by demographic properties

Epidemiology	Group A	Group B	P value
	Skeletonized (n=18)	Pedicled (n=17)	
Hypertension	11 (61.1%)	9 (52.94%)	0.625
Diabetes	7 (38.9%)	6 (35.29%)	0.890
BMI	26.49 ± 2.05	27.0 ± 2.64	0.477
Ejection fraction	56 ± 9.1	56.8 ± 7.8	0.777
Number of coronary arteries	2.6 ± 0.69	2.58 ± 0.5	0.912

Source: Real Hospital Português, Recife, PE

Table 2. Main descriptive statistics of uptake levels of the sternum in patients in groups A and B

Groups	Descriptive statistics of uptake levels of the sternum					
	n	Mean	SD*	Minimum	Median	Maximum
Group A	18	3.48	0.75	2.38	3.27	4.97
Group B	17	3.12	0.55	2.43	3.14	4.59
Difference of the means (A)-(B)		0.36**				

\*SD= Standard deviation; \*\*CI 95% for the difference of the means: 0.10 to 0.81; CI 95% = 95% Confidence interval

Table 3. Main descriptive statistics of uptake levels of the manubrium in patients in groups A and B

Groups	Descriptive statistics of uptake levels of the manubrium					
	n	Mean	SD*	Minimum	Median	Maximum
Group A	18	4.19	1.05	2.91	3.94	6.24
Group B	17	3.76	0.71	2.77	3.72	5.92
Difference of the means (A)-(B)		0.43**				

\*SD= Standard deviation; \*\*CI 95% for the difference of the means: 0.20 to 1.06; CI 95% = 95% Confidence interval

Table 4. Main descriptive statistics of uptake levels of the body in patients in groups A and B

Groups	Descriptive statistics of uptake levels of the body					
	n	Mean	SD*	Minimum	Median	Maximum
Group A	18	3.44	0.87	2.26	3.18	5.07
Group B	17	3.01	0.69	2.16	3.09	4.82
Difference of the means (A) - (B)		0.43**				

\*SD= Standard deviation; \*\*CI 95% for the difference of the means: 0.12 to 0.98; CI 95% = 95% Confidence interval

Table 5. Main descriptive statistics of uptake levels of the xiphoid in patients in groups A and B

Group	Descriptive statistics of uptake levels of the xiphoid					
	n	Mean	SD*	Minimum	Median	Maximum
Group A	18	2.48	0.51	1.66	2.44	3.43
Group B	17	2.31	0.46	1.69	2.17	3.41
Difference of the means (A) - (B)		0.16**				

\*SD= Standard deviation; \*\*CI 95% for the difference of the means: 0.18 to 0.50; CI95% = 95% Confidence interval

Table 6. Main descriptive statistics of uptake levels of the sternum in pedicled and skeletonized patients

Groups	Descriptive statistics of uptake levels of the sternum					
	n	Mean	SD*	Minimum	Median	Maximum
Group A	7	3.92	0.71	2.91	3.74	4.97
Group B	7	2.66	0.18	2.43	2.64	3.00
Difference of the means (A) - (B)		1.26**				

\*SD= Standard deviation; \*\*CI 95% for the difference of the means: 0.59 to 1.94; CI95% = 95% Confidence interval

Table 7. Main descriptive statistics of uptake levels of the manubrium in diabetic pedicled and skeletonized patients

Groups	Descriptive statistics of uptake levels of the manubrium					
	n	Mean	SD*	Minimum	Median	Maximum
Group A	7	4.73	1.08	3.09	4.62	6.24
Group B	7	3.26	0.34	2.77	3.29	3.69
Difference of the means (A) - (B)		1.47**				

\*SD= Standard deviation; \*\*CI 95% for the difference of the means: 0.45 to 2.47; CI95% = 95% Confidence interval

Table 8. Main descriptive statistics of uptake levels of the body in diabetic pedicled and skeletonized patients

Groups	Descriptive statistics of uptake levels of the body					
	n	Mean	SD*	Minimum	Median	Maximum
Group A	7	3.92	0.93	2.70	3.74	5.07
Group B	7	2.40	0.21	2.16	2.38	2.73
Difference of the means (A) - (B)		1.52**				

\*SD= Standard deviation; \*\*CI 95% for the difference of the means: 0.64 to 2.40; CI95% = 95% Confidence interval

higher compared to the mean of seven diabetic patients in group B. The difference, equal to 1.52 was statistically significant (Student's t test:  $P=0.005$ , Table 8).

In the seven diabetic patients in group A, the mean uptake levels of the xiphoid was 34.3% higher compared to the mean of seven diabetic patients in group B. The difference, equal to 0.69, was statistically significant (Student's t test:  $P=0.001$ , Table 9).

## DISCUSSION

There is growing interest in the use of arterial grafts in CABG, particularly the use of ITAs, since there is evidence that such approach may promote better late results. However, the fear persists that the sternal devascularization, resulting from the use of ITAs, lead to the mild increase in the incidence of sternal infection, especially in diabetic patients [6,9,10]. The dissection of ITAs using skeletonized technique was proposed as a possible solution to reduce the degree of sternal devascularization, by assuming that this technique would provide better preservation of collateral flow to the sternum in comparison to the technique of pedicled dissection [15,16]. No conclusion has so far been obtained, hence the importance of studies that seek to assess, by bone scintigraphy, the impact of the use of ITAs in sternal grafting. The great problem is that there has been no technical standardization of these studies.

Carrier et al. [20] performed scintigraphic evaluation in the 7th and 30th postoperative days in seven patients. Evaluation of hypoperfusion was performed based on visual identification of areas of low uptake of the tracer on the sternum and its quantification percentage in relation to the total sternal area. It was not reported the technique of ITA dissection. The results showed that there were significant hypoperfusion, after dissection of the ITA or the ITAs when compared to a control group in which the ITA was not used. This study has not identified differences between diabetics and non diabetic patients.

Rivas et al. [23] also performed bone scintigraphy on the 7th postoperative day, but using the humerus as a reference for a

Table 9. Main descriptive statistics of uptake levels of the xiphoid in diabetic pedicled and skeletonized patients

Groups	Descriptive statistics of uptake levels of the xiphoid					
	n	Means	SD*	Minimum	Median	Maximum
Group A	7	2.70	0.32	2.40	2.66	3.27
Group B	7	2.01	0.19	1.69	2.05	2.22
Difference of the means (A) - (B)		0.69**				

\*SD= Standard deviation; \*\*CI 95% for the difference of the means: 0.37 to 1.00; CI95% = 95% Confidence interval

quantitative analysis of sternal uptake. There was no statistically significant difference between patients in whom the ITA was not used and those that used the ITA or ITAs.

Cohen et al. [21] performed bone scintigraphy in two groups of patients in whom the ITAs were dissected using skeletonization technique and pedicle preparation and observed a significant decrease in uptake in the second group.

Korbmacher et al. [22] found no significant difference in sternal perfusion in a study with 44 patients divided into three groups in whom ITA was not used in 12, used in 21 and ITAs were used in 11. In this study, patients with diabetes mellitus were excluded.

More recently, Boodhwani et al. [24] used a bone scintigraphy to assess the sternal perfusion in a group of seven patients in whom were used ITAs dissected on one side through skeletonization technique and on the other, through pedicle preparation. It was noted better sternal perfusion in the side on which the ITA was dissected through skeletonization technique.

The literature review shows the need to standardize the scintigraphic study to assess the sternal perfusion, by noting the same period of the examination, the amount of tracer administered and use of the same reference for uptake quantification.

In this study, we seek to work with homogeneous groups of patients, or that is, with groups that had similar characteristics preoperatively. It was not possible, for logistical issues, to perform sternal scintigraphy preoperatively. But it does not invalidate our results, considering that we have compared scintigraphic aspects of the sternum with scintigraphic aspects of the clavicle, an structure not surgically manipulated.

It was defined the left clavicle as a reference point for evaluation of the sternum. Korbmacher et al. [22] used the cervical spine, but we supposed that the presence of other structures that are in front of the spine may lead to increased uptake, Rivas et al. [23] used the humerus, Cohen et al. [21], the contralateral half of the sternum in which the ITA has not been dissected and Boodhwani et al. [24] used the two halves of the sternum that had the ITAs dissected by different techniques. Except for one study [20] in which the uptake analysis was totally visual, all others have been based on quantitative analysis of uptake by the mean count per "pixel" by automated program.

Statistical analysis of the results in this study showed no statistically significant difference when comparing the mean uptake of the radioactive tracer, between the groups of ITA dissected by skeletonization technique (group A) and pedicle preparation (group B), although the mean uptake in the first group was greater than the second one. This lack of significance was also observed when analyzed separately the upper, middle and lower regions of the sternum. Despite the methodological differences, these results are consistent with other studies [22,23], which could not be deduced significant changes in the sternal vascularity after mobilization of one or both ITAs when compared to groups where no ITA was dissected.

These findings suggest that the use of ITAs, regardless of their technique of preparation, will not affect significantly the sternal perfusion, which raises other sources of collateral circulation, even if independent from collateral branches from the ITA, considering the low proportion of collateral branches to the sternum that can be preserved after the dissection of ITA regardless the technique used [25]. We call the attention to the possibility of part of the sternal nutrition that may come from the diffusion of nutrients from the surrounding tissues [19].

In this study, the subgroup of diabetic patients undergoing one of the different techniques of ITA dissection was assessed, noting that there was increased uptake of radioactive tracer in those in which the dissection of the ITA was performed through skeletonization technique.

This finding allows speculation that the ITA dissection by skeletonized technique may better preserve blood flow to the sternum in diabetic patients, in whom there are significant changes of microcirculation, which could explain a lower incidence of sternal infection when the mentioned technique is used [14,15]. However, definitive proof of this hypothesis requires that the study be performed with a more number of cases.

## CONCLUSION

It can be concluded, based on the findings presented herein, as follows:

1. When assessing the whole general

population, the type of ITA dissection, if pedicled or skeletonized, will not reflect itself in a statistically significant change in sternal perfusion, examined by bone scintigraphy;

2. In the subgroup of diabetic patients, the fact of both ITAs were dissected through skeletonization technique, such group showed better perfusion of the sternum when compared to the subgroup of diabetic patients who had both ITAs dissected through pedicle preparation, assessed by bone scintigraphy. Although confirmation of this finding in a larger number of cases is required, diabetic patients should have the internal thoracic arteries dissected through skeletonized technique.

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