



Does the use of the skeletonized internal thoracic artery result in less postoperative bleeding than the pedicled internal thoracic artery in coronary artery bypass surgery?

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ABSTRACT

Objective: To compare the postoperative bleeding between the skeletonized grafts and pedicled internal thoracic artery (ITA) in coronary artery bypass. **Material and Method:** 132 elective patients submitted to the surgery of myocardial revascularization were retrospectively analyzed and the sample was equally distributed in groups according to the dissection performed on the ITA: G1, skeletonized and G2, pedicled. In both methods, the dissection was finished before the heparinization and the installation of extracorporeal circulation. The following clinical parameters were evaluated: extracorporeal circulation time, aortic clamping, drainage debit and administration of hemocomponents (erythrocytes and platelets). **Results:** The average number of platelets concentrations and the drainage debit on the postoperative period were statistically higher for the pedicled dissection of the ITA compared to the skeletonized one. No statistically significant differences were observed regarding the use of one or two mammary arteries, as well as for the time of extracorporeal circulation and anoxia in the studied groups. **Conclusion:** The skeletonized preparation of the internal thoracic artery significantly reduced the blood loss after an elective surgery of myocardial revascularization.

Key words: Mammary Arteries. Myocardial Revascularization. Post-operative bleeding.

INTRODUCTION

The internal thoracic artery (ITA), is the preferable graft for coronary artery bypass graft surgery (CABG), due to greater patency and higher survival rates in long term, when compared to saphenous graft [1,2]. However, these subjects were studied independently to the internal thoracic artery dissection technique [3,4].

The first left thoracic internal artery microsurgical anastomosis to the coronary arteries was performed by

Kolessov [4] and it got a systematic performing by Green, through the pedicled dissection, comprising veins, lymphatic ducts, sympathetic plexus and intern thoracic fascia [4-6]. The skeletonization method was first described by Keeley [7], which consisted by the isolated dissection of the intern thoracic artery, alone. Keeley suggested that such technique would provide longer grafts, with the opportunity for farther anastomosis, also easing the sequential anastomosis practice [7].

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The superiority in survival rates in patients submitted to CABG who got bilateral internal thoracic artery grafts (BITA) when compared to those who received single internal thoracic artery grafts (SITA) has been shown in the early 2000's. [9]. In this report the authors demonstrate that in 10 years mean follow up period, patients on the BITA arm presented with greater survival rates, less reoperations and less interventions in comparison to those in the SITA arm.

The scarce BITA use rate seems to be related to immediate post-operative concerns, such as sternal wound infection, mainly in diabetic patients, greater bleeding, hypoperfusion due to the vasospasms predisposition, decrease in pulmonary function mainly related to the loss of pleural integrity, post-operative pain and longer time spent on the grafts dissection [3,9-12].

Even though the perception that the sternal perfusion should rely on more collateral circulation when BITA is applied, deep sternal wound infection (DSWI) prevalence difference is still controversial whether BITA or SITA techniques are performed [8]. Nevertheless, BITA should be avoided under specific conditions, such as poorly controlled diabetic or immobilized patients.

The ITA skeletonization has been proposed as the solution for many of the ITA dissection associated problems, including reduce in post-operative bleeding, better sternal perfusion, increase in graft's flow and longer length [11].

METHODS

This study has been previously approved by the Hospital Bandeirantes de São Paulo Ethical Committee (no 182109).

A retrospective analysis of 132 electives, consecutives, patients submitted to CABG alone in the Hospital Bandeirantes in São Paulo, Brazil, in the period comprehended from July 2011 to March 2012. The patients were divided into two groups: Group 1 (n=66): skeletonized ITA dissection; Group 2 (n=66): pedicled ITA dissection. The patients' characteristics on both groups are shown in Table 1.

In both methods, the ITA dissection was concluded before heparinization and bypass onset. The ITA dissection was mostly done via monopolar electrocautery (Valleylab Force 2®) in 15 watts power (coagulation) and intercostal

branches were occluded with hemoclips.

Data were collected through a data sheet containing demographic, identification, clinical, surgical (time on ECC, aortic clamp) data, immediate post-operative draining debit (until its removal) related data, also the necessity and quantification of hemocomponents administration.

Clinical and laboratorial parameters were evaluated for red cell concentrate administration. Hemodynamic instability, such as tachycardia (cardiac frequency above 100 bpm), low urinary debit (less than 10 ml/kg/h), hypotension (average arterial pressure below 60 mmHg) was linked to more than 20% loss in volemia and to the laboratorial parameters, as hematocrit below 20% during extracorporeal circulation and hemoglobin less than 7,0mg/dl.

The platelets concentrate administration was performed when less than 100.000/mm³, associated to platelet dysfunction. Fresh frozen plasma was used when INR below 1,5 and/or a minimum PTT of 1,5 times the control after effective heparin inactivation with protamine.

Age, distal anastomosis number, quantity of each hemoderivative were described according to groups, using means and standard deviations; groups were then compared via tStudent tests [13]. Gender and comorbidities incidence were described using absolute and relative frequencies and association existence was verified through chi square tests [13].

The use of one or both ITA's and the need of reoperation due to bleeding complications were described according to groups and associations were verified with Fisher exact tests [13].

Postoperative bleeding was described using mean, standard deviation, median, minimum and maximum and comparison between groups with Mann Whitney tests, and the results shown in a Box-plot graph [13]. Tests were applied with significance level of 5%.

RESULTS

The patients in the pedicled ITA group were statistically older than those in the skeletonized ITA group ($p=0,004$) and presented with lower systemic arterial hypertension prevalence ($p=0,012$). Concerning sex and diabetes, there were no statistically significant correlations in between the groups ($p>0,05$) (Table 1).

Table 1. Description of personal characteristics and comorbidities according to groups and statistic tests results.

Group					
Patient Characteristics Skeletonized (N = 66) Pedicled (N = 66)					
p	n	%	n	%	
Sex					0,709
Male	44	66,7	46	69,7	
Female	22	33,3	20	30,3	
Age (years)					0,004*
Mean (SD)	59,4 (9,1)		64,5 (10,8)		
SAH					0,012
No	6	9,1	17	25,8	
Yes	60	90,9	49	74,2	
DM					0,582
No	42	63,6	45	68,2	
Yes	24	36,4	21	31,8	

Qui-quadrante test result; * t-Student test result

Results showed that only a patient, belonging to the pedicled ITA dissection group submitted to reoperation due to bleeding complications, with no statistically significant association in between the groups concerning the referred

reoperation ($p > 0,999$). The use of one or both ITA's also did not show any statistically significant association among the groups ($p > 0,718$) (Table 2).

Table 2. Description of the procedures characteristics according to the groups and the statistic tests results.

Group					
Intraoperative Data Skeletonized (N = 66) Pedicled (N = 66)					
p	n	%	n	%	
Reoperation					>0,999
No	66	100,0	65	98,5	
Yes	0	0,0	1	1,5	
ITA use					0,718
SITA	61	92,4	63	95,5	
BITA	5	7,6	3	4,5	
Distal anastomosis					0,013**
mean (SD)	2,2 (0,8)		2,6 (0,9)		

Fisher's exact test result; * t-Student test result

Blood
Product

The mean bypass time in the skeletonized ITA and pedicled ITA dissection groups was respectively 61,3 and 61,6 minutes, with no difference in between the groups ($p=0,486$). Also, the mean cross clamping time showed no statistical difference in between the groups ($p=0,431$), consisting 49,2 and 50,2 minutes in the skeletonized ITA and pedicled ITA dissection groups, respectively. The number of distal anastomosis was statistically superior in

patients belonging to the pedicled ITA dissection group ($p=0,013$). There were no hospital deaths or mediastinitis cases in either groups.

The necessity of platelets transfusion was statistically superior in the pedicled ITA dissection group patients ($p=0,011$). Other blood products showed no statistical difference among groups ($p>0,05$) (Table 3).

Table 3. Description of the number of blood products administered according to study groups.

Variable	Group		p
	Skeletonized (N=66)	Pedicled (N=66)	
Blood Product	mean (SD)	mean (SD)	
RBPC	1,4 (1,6)	1,9 (1,7)	0,056
FFP	1,3 (1,9)	1,6 (1,8)	0,357
PC	2,5 (4,0)	4,5 (4,9)	0,011

t-Student test result

Chest tube drainage was statistically superior in the pedicled ITA dissection group patients ($p<0,001$) (Figure 1 and Table 4).

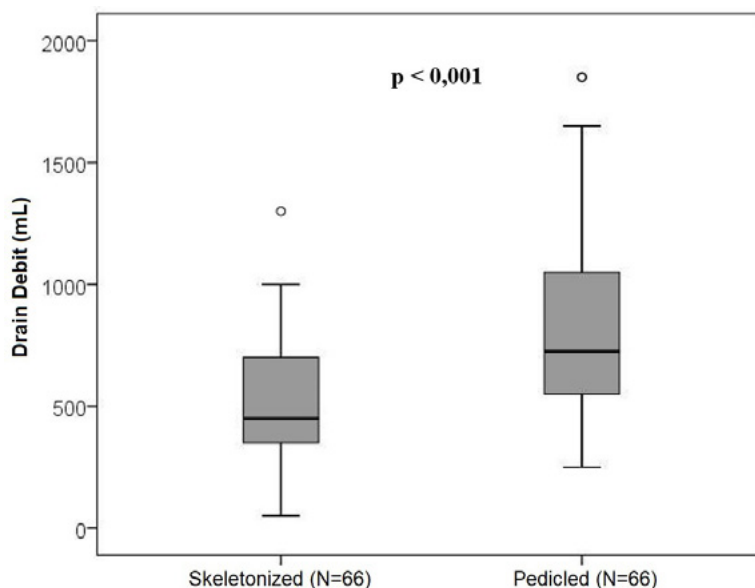


Figure 1. Drain debit box-plot according to groups and comparative tests results

Table 4. Chest tube drainage flow among groups.

Variable	Group		p
	Skeletonized (N = 66)	Pedicled (N = 66)	
Chest Tube Drainage			<0,001
(mL) mean (SD)	505,8 (248)	831,9 (389,3)	
median (min.; max.)	450 (50; 1300)	725 (250; 1850)	

Mann-Whitney test result

DISCUSSION

There has been in the past two decades a blooming interest in myocardial revascularization surgery using arterial grafts, with highlights to the intern thoracic arteries (ITA), with evidences that this management promotes better late results [14].

Despite the long-term excellent results on the ITA coronary revascularization surgery, technical aspects, such as the dissection method, could lead to the increase on post-operative morbidity [10,15-17]. Considering that, extensive research demonstrated the skeletonized ITA superiority in comparison to the ITA pedicled dissection [1,3,8,10,11,14-16,18,20].

There are multiple reasons for choosing the skeletonized ITA dissection: excellent flow quality with less ITA spasms, increase in length and diameter, better sequential grafting performing, less sternal irrigation depletion, with consequent decrease on sternal wound infection, mainly in diabetics [8,18,19-21]. There is no mention on greater vasoreactivity problems or functional intern thoracic artery integrity issues [19]. However, studies comparing post-operative bleeding among skeletonized and pedicled ITA dissection techniques are seldom.

In this study, we observed less post operative bleeding in patients with skeletonized ITA dissection comparing to those submitted to the pedicled ITA dissection. The platelet concentrate administration was statically higher in the pedicled dissection group and no statistical association was found for other blood products among groups.

The fewer post-operative bleedings and blood products use (fresh and frozen plasma and red cells concentrate) as verified in the current analysis, matches

with a prospective study by Wimmer-Greinecker et al. [3]. Following a prospective analysis of 112 patients distributed in 2 groups; group 1: skeletonized ITA and intact pleura (n=55) and group 2: pediculated ITA and open pleura (n=57), less post-operative bleeding in the group with skeletonized approach was observed. Clinical and surgical aspects such as gender, aortic cross clamping time, CPB (Cardio-Pulmonary bypass) time, also did not present statistical difference among groups.

According to Wimmer-Greinecker et al [3], the post-operative blood loss in the first 12 hours was significantly higher in the pediculated ITA group in comparison to the skeletonized ITA group. However, there was not any statically significant difference between the postoperative need for fresh frozen plasma (FFP) and packed red blood cells (PRBC) between the two groups.

Several measures may be adopted in heart surgery care to try to reduce the need of blood products use aiming the reduction of bleeding events, with consequent reduction of morbidity and mortality [22]. The blood transfusion is related to the occurrence of transfusion reaction, infection transfer, increasing of morbidity, mortality post-operative, immunosuppression risk and increase of hospitalization cost [22-24]. Cardiac surgery patients use 10 to 25% of the blood products transfused annually in The United States [25].

The post-operative bleeding occurrence of bleeding is a frequent complication in cardiovascular surgeries. About one-third of operated patients needed blood transfusion, being responsible for 10% - 15% of blood components in United States [25].

The blood transfusion is related to the increase of renal insufficiency occurrence, infection, respiratory, cardiac

affections and neurological complications in transfused patients in comparison with the non-transfused following cardiac surgery. According to Dorneles et al. [24], the occurrence of bleeding is a frequent complication in cardiovascular surgeries. About one-third of operated patients needed blood transfusion, being responsible for 10% - 15% of blood components in United States [24]. Researches revealed that blood transfusion is related to post-operative complications such as atrial fibrillation (AF), low cardiac output syndrome (LOCS), acute myocardial infarction, stroke, renal failure and sepsis [26,26]. The AF is a common complication following cardiac surgeries, occurring between 10-13% of operated patients, contributing to the morbidity and the grow of hospital permanence of these patients. Koch et al [26], evaluated the risk of developing AF in patients submitted to blood transfusion after cardiac surgery, and concluded that the transfusion is a risk factor for developing AF in post-operative period, and the risk rises according to each transfused unity (OR: 1,2; IC 95%: 1,1-1,3; p<0,0001) [24, 26-28].

Finally, it is assumed that the major fact leading to the reduction of excessive blood products use can be the adoption of insightful routines and designed by surgical team [22].

This study has some potential limitation since it is based on data from a single center, in a retrospective and non-randomized design. Therefore, composition of catchment population, departmental protocols, resources and staffing characteristics are also potential limits to the generalizability of our results.

CONCLUSION

In this retrospective, single center analysis, the use of skeletonized internal thoracic artery significantly reduced the blood loss in the post-operative period in elective myocardial revascularization surgery, in comparison to the use of pediculated internal thoracic artery.

REFERÊNCIAS

1. Castro GP, Dussin LH, Wender OB, Barbosa GV, Saadi EK. Comparative analysis of the flows of left internal thoracic artery grafts dissected in the pedicled versus skeletonized manner for myocardial revascularization surgery. *Arq Bras Cardiol.* 2005;84(3):261-6. <http://dx.doi.org/10.1590/s0066-782x2005000300013>
2. Lytle BW, Blackstone EH, Loop FD, Houghtaling PL, Arnold JH, Akhrass R, et al. Two internal thoracic artery grafts are better than one. *J Thorac Cardiovasc Surg.* 1999;117(5):855-72. [http://dx.doi.org/10.1016/S0022-5223\(99\)70365-X](http://dx.doi.org/10.1016/S0022-5223(99)70365-X).
3. Wimmer-Greinecker G, Yosseef-Hakimi M, Rinne T, Buhl R, Matheis G, Martens S, et al. Effect of internal thoracic artery preparation on blood loss, lung function, and pain. *Ann Thorac Surg.* 1999;67(4):1078-82. [https://doi.org/10.1016/S0003-4975\(99\)00161-7](https://doi.org/10.1016/S0003-4975(99)00161-7)
4. Kolessov VI. Mammary artery-coronary artery anastomosis as method of treatment for angina pectoris. *J Thorac Cardiovasc Surg.* 1967;54(4):535-44.
5. Deja MA, Wos S, Golba KS, Zurek P, Domaradzki W, Bachowski R, et al. Intraoperative and laboratory evaluation of skeletonized versus pedicled internal thoracic artery. *Ann Thorac Surg.* 1999;68(6):2164-8.
6. Green GE. Technique of internal mammary-coronary artery anastomosis. *J Thorac Cardiovasc Surg.* 1979;78(3):455-9.
7. Keeley SB. The skeletonized internal mammary artery. *Ann Thorac Surg.* 1987;44(3):324-5
8. Lazar, HL. The risk of mediastinitis and deep sternal wound infections with single and bilateral, pedicled and skeletonized internal thoracic arteries. *Annals of cardiothoracic surgery.* 2018; 7(5):663. <http://dx.doi.org/10.21037/acs.2018.06.11>
9. Lytle BW, Blackstone EH, Sabik JF, Houghtaling P, Loop FD, Cosgrove DM. The effect of bilateral internal thoracic artery grafting on survival during 20 postoperative years. *Ann Thorac Surg.* 2004;78(6):2005-12. <https://doi.org/10.1016/j.athoracsur.2004.05.070>
10. Sa MP, Soares EF, Santos CA, Figueiredo OJ, Lima RO, Escobar RR, et al. Skeletonized left internal thoracic artery is associated with lower rates of mediastinitis in diabetic patients. *Rev Bras Cir Cardiovasc.* 2011;26(2):183-9.
11. De Paulis R, De Notaris S, Scaffa R, Nardella S, Zeitani J, Del Giudice C, et al. The effect of bilateral internal thoracic artery harvesting on superficial and deep sternal infection: the role of

- skeletonization. *J Thorac Cardiovasc Surg*. 2005;129(3):536-43.
12. Boodhwani M, Nathan HJ, Lam BK, Rubens FD. The internal thoracic artery skeletonization study: a paired, within-patient comparison [NCT00265499]. *Trials*. 2006;7:1.
 13. Kirkwood BR, Sterne JAC. *Essential medical statistics*. 2ed. Massachusetts: Blackwell Science; 2006.
 14. Dos Santos Filho EC, Moraes Neto FR, Silva RA, Moraes CR. Should the diabetics have the internal thoracic artery skeletonized? Assessment of sternal perfusion by scintillography. *Rev Bras Cir Cardiovasc*. 2009;24(2):157-64.
 15. Boodhwani M, Lam BK, Nathan HJ, Mesana TG, Ruel M, Zeng W, et al. Skeletonized internal thoracic artery harvest reduces pain and dysesthesia and improves sternal perfusion after coronary artery bypass surgery: a randomized, double-blind, within-patient comparison. *Circulation*. 2006;114(8):766-73.
 16. Markman PL, Rowland MA, Leong JY, Van Der Merwe J, Storey E, Marasco S, et al. Skeletonized internal thoracic artery harvesting reduces chest wall dysesthesia after coronary bypass surgery. *J Thorac Cardiovasc Surg*. 2010;139(3):674-9.
 17. Del Campo C. Pedicled or skeletonized? A review of the internal thoracic artery graft. *Tex Heart Inst*. 2003;30(3):170-5.
 18. Cunningham JM. Skeletonization of the internal thoracic artery: pros and cons. *Ann Thorac Surg*. 2006;81(1):405-6.
 19. Gaudino M, Trani C, Glieca F, Mazzari MA, Rigattieri S, Nasso G, et al. Early vasoreactive profile of skeletonized versus pedicled internal thoracic artery grafts. *J Thorac Cardiovasc Surg*. 2003;125(3):638-41.
 20. Wendler O, Tscholl D, Huang Q, Schafers HJ. Free flow capacity of skeletonized versus pedicled internal thoracic artery grafts in coronary artery bypass grafts. *Eur J Cardiothorac Surg*. 1999;15(3):247-50.
 21. Peterson MD, Borger MA, Rao V, Peniston CM, Feindel CM. Skeletonization of bilateral internal thoracic artery grafts lowers the risk of sternal infection in patients with diabetes. *J Thorac Cardiovasc Surg*. 2003;126(5):1314-9.
 22. Alghamdi AA, Davis A, Brister S, Corey P, Logan A. Deve lopment and validation of Transfusion Risk Understanding Scoring Tool (TRUST) to stratify cardiac surgery patients according to their blood transfusion needs. *Transfusion*. 2006;46(7):1120-9.
 23. Souza HJBD, Moitinho RF. Estratégias para redução do uso de hemoderivados em cirurgia cardiovascular. *Rev Bras Cir Cardiovasc*. 2008;23:53-9.
 24. Dorneles CDC, Bodanese LC, Guaragna JCVDC, Macagnan FE, Coelho JC, Borges AP, et al. O impacto da hemotransfusão na morbimortalidade pós-operatória de cirurgias cardíacas. *Rev Bras Cir Cardiovasc*. 2011;26:222-9.
 25. Whitlock, Richard, Mark A. Crowther, and Heng J. Ng. "Bleeding in cardiac surgery: its prevention and treatment—an evidence-based review." *Critical care clinics* 21.3(2005):589610.
 26. Koch CG, Li L, Duncan AI, Mihaljevic T, Cosgrove DM, Loop FD, et al. Morbidity and mortality risk associated with red blood cell and blood-component transfusion in isolated coronary artery bypass grafting. *Crit Care Med*. 2006;34(6):1608-16.
 27. Karkouti K, O'Farrell R, Yau TM, Beattie WS. Prediction of massive blood transfusion in cardiac surgery. *Can J Anaesth*. 2006;53(8):781-94.
 28. Koch CG, Li L, Van Wagoner DR, Duncan AI, Gillinov AM, Blackstone EH. Red cell transfusion is associated with an increased risk for postoperative atrial fibrillation. *Ann Thorac Surg*. 2006;82(5):1747-56.