Turkish J Thorac Cardiovasc Surg
2005;13:112-114

CARDIAC SURGERY

İnternal Mammaryan Arter skeletonizasyonunun Akım ve Boy Üzerine Etkileri

EFFECT OF SKELETONIZATION ON FLOW AND LENGTH OF INTERNAL THORACIC ARTERY

Tamer Türk, Osman Tiryakioğlu, Ahmet Hakan Vural, Yusuf Ata, Özer Selimoğlu, Şenol Yavuz

Bursa Yüksek İhtisas Eğitim ve Araştırma Hastanesi, Kalp Damar Cerrahisi Kliniği, Bursa

Özet

Amaç: İnternal torasik arter koroner arter cerrahisinde altın standart olarak kabul edilen greft seçeneğidir. İnternal torasik arterin iskeletizasyonu boy ve akımında artmaya ve daha distal anastomoz uygulamasına olanak tanıdığı düşünülmektedir. Bu çalışmada pediküllü hazırlanan internal torasik arter greftinin üzerinde iskeletizasyonun akım ve boy üzerine etkilerini araştırdık.
Materyal ve Metod: Toplam 52 hastaya iskeletize edilmiş internal torasik arter kullanılarak koroner arter cerrahisi uygulandı. İnternal torasik arter pediküllü olarak çıkarılarak püskürtme papaverin uygulaması sonrası akım ve boy ölçümü yapıldı. İkinci adımda internal torasik arter iskeletize edilip püskürtme papaverin uygulaması sonucu aynı işlem tekrarlandı.
Bulgular: Ortalama boy ölçümü pediküllü internal torasik arterde 16.8 ± 0.7 cm, iskeletize formda ise 18.9 ± 0.5 cm olarak ölçüldü ($p < 0.001$). Serbest akım ölçümünde pediküllü internal torasik arterde 59.4 ± 5.47 ml iken iskeletize formda 96.3 ± 5.3 ml olarak ölçüldü ($p < 0.001$). Yetersiz akım ya da uzunluk nedeni ile kullanılamayan internal torasik arter grefti olmadı.
Sonuç: İnternal torasik arterin iskeletizasyonu greft boyunda ve akımında anlamlı derecede artmayı sağlamakta bu da internal torasik arter hipoperfüzyonu riskini azaltmakta ve daha distal anastomoz yapabilmeye olanak sağlamaktadır.

Anahtar kelimeler: Koroner arter cerrahisi, İnternal torasik arter, iskeletizasyon

Türk Göğüs Kalp Damar Cer Derg 2005;13:112-114

Summary

Backgorund: The internal thoracic artery (ITA) is the best conduit of choice for surgical treatment of coronary artery disease. Skeletonization of this arterial conduit seems to improve the graft length, flow and allow constructing sequential anastomoses. In this study length and blood flow of both pedicled and skeletonized forms of ITA are compared on the same conduits.
Methods: Totaly 52 patients underwent coronary artery bypass grafting with the use of skeletonized left internal thoracic artery (LITA). LITA was harvested with a pedicle and papaverine was sprayed over the LITA, after that length and flow of pedicled LITA were measured. At the second step the LITA was skeletonized from the pedicle and papaverine was sprayed over the skeletonized LITA and the second measurements of length and flow were done.
Results: The length of pedicled LITA was 16.8 ± 0.7 cm. versus 18.9 ± 0.5 cm in skeletonized form ($p < 0.001$). The free blood flow was 59.4 ± 5.4 ml. in pedicled LITA versus 96.3 ± 5.3 ml in the skeletonized form ($p < 0.001$). There were no LITA grafts that are not grafted because of insufficient length or insufficient flow.
Conclusion: Skeletonization of the LITA results in significantly higher blood flow and available length of the graft. This reduces the risk of LITA hypoperfusion syndrome and improved length of the conduit allows more distal coronary artery anastomoses.

Keywords: Coronary surgery, internal thoracic artery, skeletonization

Turkish J Thorac Cardiovasc Surg 2005;13:112-114

Geliş Tarihi: Nisan 2004 Revizyon: Eylül 2004 Kabul Tarihi: 3 Şubat 2005

Introduction

ITA has become the conduit of choice for CABG after its initial use by Kolessov [1] and the first systematic usage of the conduit by Green [2]. ITA grafts remains potent and free from atherosclerosis for a longer time when it is compared with saphenous vein grafts, these lead many surgeons to more frequent use of arterial grafts and sequential arterial anastomoses. Increase in usage of LITA bring out some problems such as; perioperative arterial spasm, insufficient flow and length; although harvesting of the conduit is done with the use of topical vasodilators.
To overcome such problems besides pedicled harvesting technique of the ITA, skeletonization is described by Keeley and associates [3], which improved sufficient length and blood flow of the conduit and allow easier construction of sequential

Adres: *Dr. Tamer Türk, Bursa Yüksek İhtisas Eğitim ve Araştırma Hastanesi, Kalp Damar Cerrahisi Kliniği, Bursa*
e-mail: *tturkon@yahoo.com*

anastomoses.
In this study we compared blood flow and length of the LITA in both forms pedicled or skeletonized on the same conduits.

Material and Methods

52 patients underwent elective CABG surgery with the use of skeletonized LITA at our institution. 34 (65%) of the patients were male and 18 (35%) were female aged between 36 to 72. 11 patients had NIDDM. 17 had prior MI. 2 patients had mild mitral insufficiency that did not need surgical intervention. After harvesting the ITA patients were paired into two groups pedicled ITA and skeletonized ITA.
Only patients who underwent either on-pump or off-pump CABG surgery with the use of LITA-LAD graft were included. Patients who underwent urgent CABG surgery or concomitant valve replacement were not included.

Technique
LITA preparation is performed in the pedicled form as it is harvested at most institutions together with concomitant veins, lymphatics, sympathetic plexus and internal thoracic fascia. The preparations of all ITA's are performed by the use of an electrocautery.
After complete preparation of the LITA graft and heparinization the pedicled graft is transected at the bifurcation. Then LITA is sprayed with diluted papaverine (50mg/20ml) 10 minutes later free blood flow of LITA is measured by allowing the graft to bleed in to a 200ml container for 30 sec (Flow 1). Distal end is occluded by the help of a bulldog clamp and length of the LITA graft is measured from subclavian artery to the bifurcation point with the help of a sterile ruler (cm) (Length I).
After the measurements were done with the pedicled graft LITA is skeletonized from the pedicle using small scissor and titanium hemoclips where needed.
After dissecting accompanying veins, parietal pleura and intercostal muscle away from the artery again the skeletonized LITA is sprayed with diluted papaverine, 10 minutes later Flow II and Length II is measured in the same manner of the first measurements.
Mean arterial pressures and heart rates were noted at the time of flow the measurements and there were no statisticaly significant difference.
Statistical Analysis
Data were analyzed with SPSS (windows 6.1) paired samples-t test. Flow and length measurement data were expressed as mean ± standard deviation. A p-value of less than 0.05 was considered to be statistically significant.

Results

Baseline characteristics of patients are shown in Table 1. Skeletonization of ITA seems to be a good technique that can be used perioperatively. In our study we found that there is a statistically significant increase in the skeletonized LITA graft length when compared with the pedicled form (16.8 ± 0.7 versus 18.9 ± 0.5) ($p < 0.001$). This gave us the opportunity for more distal coronary anastomosis if needed.
Free blood flow of skeletonized form of the LITA graft showed a statistically significant increase when compared with the pedicled form of LITA graft (59.4 ± 5.4 versus 96.3 ± 5.3) ($p < 0.001$) both forms of the conduit was sprayed with (50mg/20cc) papaverine 10 minutes before the measurement. Measurments of flow and length are shown on Table II. Mean arterial pressure at the time of the measurements of Flow I and Flow II was 70.3 ± 2.2 versus 70.2 ± 2 respectively and there were no statistically significant difference Table 2. With this measurement results there were no LITA grafts that were not used because of insufficient flow and hypoperfusion syndrome. There was no hospital mortality. Two patients had peroperative inferior MI. There were no sternal dehiscences.

Discussion

Improved patency rates and long term survival of ITA when compared with sapheneus vein grafts has made ITA to be the best choice of conduit for CABG [4-8]. These lead many surgeons to routine use of ITA which brings out problems such as insufficient flow and length. Insufficient flow of ITA may cause hypoperfusion syndrome in CABG which has a high mortality [9].
Topical vasodilators and skeletonization were used to overcome these problems.

Tablo 1. Baseline characteristics of patients.

Age	60.1 ± 8.1
Gender M/F	34/18
DM	11 (21%)
HT	27 (52%)
BSA	1.76 ± 0.09
COPD	11 (21%)
Previous MI	17 (32%)
Smoking	25 (48%)

BSA = body surface area; COPD = chronic obstructive pulmonary disease; DM = diabetes mellitus; HT = hypertension;

Tablo 2. Statistics of measurements and haemodynamic variables.

Variables	**Pedicled ITA**	**Skeleton ITA**	***p****
MAP (mmHg)	70.3 ± 2.2	70.2 ± 2	$p > 0.05$
H R (beats/min)	75.4 ± 3.6	74.9 ± 3.3	$p > 0.05$
Length (cm)	16.8 ± 0.7	18.9 ± 0.5	$p < 0.001$
Flow (ml/min)	59.4 ± 5.4	96.3 ± 5.3	$p < 0.001$

HR = heart rate; MAP = mean arterial pressure
*P < 0.05 is considered as statistically significant

Skeletonization of the ITA was first described by Keeley [3] in 1987. After this some groups showed that by skeletonization free flow and length of the ITA increased and risk of hypoperfusion syndrome is decreased [3,10,11]. Besides impaired length and free flow, preparing the ITA with the skeletonization technique and leaving the accompanying veins in the chest wall causes less trauma and mostly pleural cavity remains intact. Bonacchi et al. [12] in their study with 299 patients showed that harvesting of ITA in the skeletonized fashion without opening the pleural cavity results in altered postoperative chest pain, impaired postoperative respiratory function and significantly higher bleeding in patients with open pleural cavity and pedicled ITA preparation.

In Choi's investigation free flow of pedicled and skeletonized grafts was not significantly different [13]. But in their study they compared pedicled ITA's treated with intraluminal papaverine versus skeletonized ITA's only sprayed with papaverine. Gurewitch and colleques [14] applied 1/30 diluted papaverine to the ITA and flow of the arterial graft was measured over 150ml/min. We applied diluted papaverine to the both forms of the same ITA's (first pedicled and second skeletonized form of the same ITA).

Deja and colleques [11] showed that the length of the skeletonized ITA's were higher 17.8 ± 1.1 cm versus 20.3 ± 0.5 cm. and the flow of skeletonized ITA's were significantly higher. 66.3 ± 7.4 ml/min versus 100.3 ± 14.8 ml/min. Our study showed that length of the same patients ITA's increased from 16.8 ± 0.7 cm to 18.9 ± 0.5 cm and free flows of the same ITA's increased from 59.4 ± 5.4 ml/min to 96.3 ± 5.3 ml/min.

Wendler and colleques [15] obtained significantly higher free flow in the skeletonized ITA after treatment with papaverine. Different from our study they used papaverine intraluminaly.

Some investigators showed damage of the endothelium by intraluminal application of papaverine and recommended only external application [16]. In our study we sprayed papaverine only externally.

Deja and friends found free blood flow of skeletonized LITA twice as high as the pedicled form [11]. Local symphatectomy that probably occurs during skeletonization may be an explanation. According to Deja skeletonized LITA was transected at a higher level at which the diameter of the graft is higher than its distal segments and additionally spraying diluted papaverine on the naked wall of the artery might have more direct effect than on the one that is pedicled [11].

But in our investigation we measured free flow of the ITA's both skeletonized and pedicled on the some patients and we did not transect the LITA at a higher level the measurements are done at the same transection level. But local symphatectomy and direct effect of diluted papaverine on the naked wall cannot be under estimated.

Nevertheless we think every surgeon would be pleased for a higher blood flow through the bypass conduit at the early postoperative period, whatever the mechanism that produces this higher flow.

As a conclusion the skeletonization of ITA has advantages like increase in the grafts length and increase in the free flow of the graft. This gives a comfort to the surgeon for more distal LAD anastomoses and reducing the risk of ITA hypoperfusion syndrome.

References

1. Kolessov VI. Mammary artery-coronary artery anastomosis as method of treatment for angina pectoris. J Thorac Cardiovasc Surg 1967;54:535-44.
2. Green GE, Stertzer SH, Reppert EH. Coronary arterial bypass grafts. Ann Thorac Surg 1968;5:443-50.
3. Keeley SB. The skeletonized internal mammary artery. Ann Thorac Surg 1987; 44:324-5.
4. Cameron A, Davis KB, Green G, Schaff HV. Coronary bypass surgery with internal thoracic artery grafts- effects on survival over a 15-year period. N Engl J Med 1996;334:216-9.
5. Galbut DL, Traad EA, Dorman MJ, et al. Seventeen-year experience with bilateral internal mammary arery grafts. Ann Thorac Surg 1990;49:195-201.
6. Fiore AC, Naunheim KS, Dean P, et al. Results of internal thoracic artery grafting over 15 years: Single versus double grafts. Ann Thorac Surg 1990;49:202-9.
7. Bical O, Braunberger E, Fischer M, et al. Bilateral skeletonized mammary artery grafting: Experience with 560 consecutive patients. Eur J Cardiothorac Surg 1996;10:971-6.
8. Calafiore AM, Di Giammarco G, Luciani N, Maddestra N, Di Nardo E, Angelini R. Composite arterial conduits for a wider arterial myocardial revascularization. Ann Thorac Surg 1994;58:185-90.
9. Jones EL, Lattouf AM, Weintraub WS. Catastrophic consequences of the internal mammary artery hypoperfusion. J Thorac Cardiovasc Surg 1989;98:902-7.
10. Gurevitch J, Paz Y, Shapira I, et al. Routine use of bilateral skeletonized internal mammary arteries for myocardial revascularization. Ann Thorac Surg 1999;67:1637-42.
11. Deja MA, Wos S, Golba KS, et al. Intraoperative and laboratory evaluation of skeletonized versus pedicled internal thoracic artery. Ann Thorac Surg 1999;68:2164-8.
12. Bonacchi M, Prifti E, Giunti G, Salica A, Frati G, Sani G. Respiratory disfunction after coronary artery bypass grafting employing bilateral internal mammary arteries: the influence of intact pleura. Eur J Cardiothorac Surg. 2001;19:827-33.
13. Choi JB, Lee SY. Skeletonized and pedicled internal thoracic artery grafts: effect on free flow during bypass. Ann Thorac Surg 1996;61:909-13.
14. Gurevitch J, Kramer A, Locker C, et al. Technical aspects of double skeletonized internal mammary artery grafting. Ann Thorac Surg 2000;69:841-6.
15. Wendler O, Tscholl D, Huang Q, Schaffers HJ. Free flow capacity of skeletonized versus pedicled internal thoracic artery grafts in coronary artery bypass grafts. Eur J Cardiothorac Surg 1999;15:247-50.
16. Noera G, Pensa P, Lodi R, Lamarra M, Biagi B, Guelfi P. Influence of different harvesting techniques on the arterial wall of the internal mammary artery graft: Microscopic analysis. Thorac Cardiovasc Surg 1993;41:16-20.