The Heart Surgery Forum #2009-1191
13 (4), 2010 [Epub August 2010]
doi: 10.1532/HSF98.20091191

Online address: http://cardenjennings.metapress.com

Steal from Skeletonized Internal Thoracic Artery Graft during Hemodialysis after Coronary Artery Bypass Grafting

Takeshi Kinoshita, MD,[1] Tohru Asai, MD, PhD,[1] Takako Ishigaki[2]

Departments of [1]Cardiovascular Surgery and [2]Clinical Laboratory, Shiga University of Medical Science, Otsu, Japan

ABSTRACT

Background: We used transthoracic Doppler echocardiography to evaluate the potential for flow variation in a skeletonized internal thoracic artery (ITA) graftc ipsilateral to an upper-extremity arteriovenous fistula during postoperative hemodialysis.

Methods: Between October 2008 and May 2009, 7 patients in chronic hemodialysis underwent coronary artery bypass grafting. We selected 5 of these patients according to the following inclusion criteria: patients who were undergoing chronic hemodialysis via a left upper-extremity arteriovenous fistula and in whom the skeletonized left ITA was anastomosed to the left anterior descending artery as an in situ graft; the right ITA was not used as a graft; postoperative multidetector computed tomography evaluation of the coronary artery demonstrated patency of the left ITA. The following parameters were calculated at baseline, after the dialysis pump was on, before the pump was turned off, and after the pump was off: peak systolic velocity, end-diastolic velocity, time-averaged mean velocity, pulsatility index, and ITA diameter. Flow was calculated with the following formula: Flow = Time-Averaged Mean Velocity × (Half the Diameter of the ITA)^2 × 60 × π.

Results: When the hemodialysis pump was started, there was a significant reduction in the flow of the left ITA (P = .01), whereas there was no variation in the flow of the right ITA (P = .54). During dialysis, no patients experienced hypotension, arrhythmia, or angina. Just after the end of dialysis, the left ITA flow significantly increased (P = .01).

Conclusions: Flow reduction of the ITA graft ipsilateral to an upper-extremity arteriovenous fistula develops during postoperative hemodialysis, even when the skeletonization technique is used.

INTRODUCTION

The National Kidney Foundation Kidney Disease Outcomes Quality Initiative guidelines recommend that coronary artery bypass grafting is an appropriate revascularization technique for dialysis patients, especially in those with 3-vessel and/or left main disease, and may also be preferred in patients who are candidates for the use of an internal thoracic artery (ITA) graft [K/DOQI Workgroup 2005]. Some investigators have demonstrated a reduction in flow of an ITA graft ipsilateral to an upper-extremity arteriovenous fistula and clinical symptoms suggestive of myocardial ischemia during postoperative hemodialysis [Crowley 2002; Gaudino 2003; Kato 2003]. In those studies, however, a pedicled ITA was used in all patients. Limited information is available about the ITA harvested with a skeletonization technique. We used transthoracic Doppler echocardiography to evaluate the potential for flow variation in a skeletonized ITA graft ipsilateral to an upper-extremity arteriovenous fistula during postoperative hemodialysis.

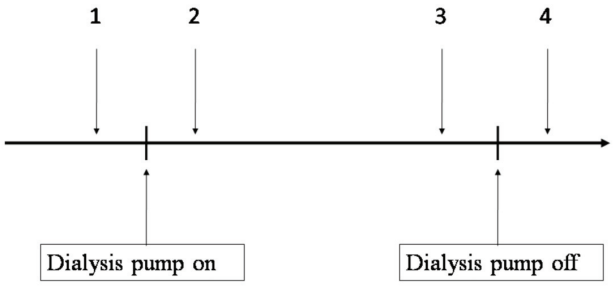
Received December 7, 2009; accepted February 2, 2010.

Correspondence: Takeshi Kinoshita, MD, Department of Cardiovascular Surgery, Shiga University of Medical Science, Setatsukinowa, Otsu, Shiga, 520-2192 Japan; +81-77-548-2244; fax: +81-77-544-2901 (e-mail: kinotake@belle.shiga-med.ac.jp).

MATERIALS AND METHODS

Study Population

Between October 2008 and May 2009, 7 patients in chronic hemodialysis underwent coronary artery bypass grafting at our institution. We selected 5 of these patients according to the following inclusion criteria: patients who were undergoing chronic hemodialysis via a left upper-extremity arteriovenous fistula and in whom the skeletonized left ITA was anastomosed to the left anterior descending artery as an in situ graft. The right ITA was not used as a graft. Postoperative multidetector computed tomography of the coronary artery demonstrated patency of the left ITA. All of the data were collected prospectively. All patients had previously granted permission for use of their medical records for research purposes.



Timing of Doppler echocardiography examinations at baseline (1), after the pump was turned on (2), before the pump was turned off (3), and after the pump was turned off (4).

Operative Technique

All procedures were performed through a median sternotomy. The left ITA was harvested by the skeletonization technique with an ultrasonic scalpel (Harmonic Scalpel; Ethicon Endo-Surgery, Cincinnati, OH, USA) in all patients [Higami 2000, 2001]. The left ITA was anastomosed to the left anterior descending artery as an in situ graft through a left-side pericardial incision. The distal anastomosis was constructed with 7-0 polypropylene continuous suture.

Evaluation of ITA Flow

Transthoracic Doppler echocardiography has been widely applied in clinical practice for noninvasive assessment of ITA graft patency [De Bono 1992; van Son 1993; Crowley 1995]. Doppler echocardiography evaluation of the ITA flow was performed with a computerized system (Vivid i Cardiovascular Ultrasound System; GE Healthcare, Milwaukee, WI, USA). The patients were studied in the supine position. The ITA was detected in the second intercostal space. Color Doppler imaging was obtained with a constant angle of 60 degrees between the ultrasound beam and the long axis of the vessel. The following parameters were calculated at baseline, after the dialysis pump was turned on, before the pump was turned off, and after the pump was turned off (Figure): peak systolic velocity (PSV), end-diastolic velocity (EDV), time-averaged mean velocity (TAMV), and the pulsatility index (PI = PSV – EDV/TAMV). The TAMV was defined as the area between the line traced on the Doppler wave and the baseline. The diameter of the ITA was calculated by using internal electronic calipers on frozen-frame images from the B-mode recording. Flow was calculated according to the formula: Flow = TAMV × πr^2 × 60, where r is half the diameter of the ITA in centimeters. Arterial pressure was recorded every 2 minutes, and the mean arterial pressure was maintained at approximately 60 to 70 mm Hg. All measurements were performed by a single physician (T.I.) and were repeated at least 5 times.

Statistical Analysis

Data for continuous variables were summarized as the mean and SD and were compared statistically with the

Detailed Results of the Doppler Echocardiography Measurements*

	Baseline	After Pump On	*P*	Before Pump Off	After Pump Off	*P*
Left ITA						
PSV, cm/s	59 (11)	40 (9)	.01	35 (2)	54 (4)	.01
EDV, cm/s	7 (3)	6 (3)	.45	4 (1)	6 (3)	.56
TAMV, cm/s	37 (18)	23 (10)	.02	24 (10)	32 (12)	.03
PI	1.4 (0.5)	1.5 (0.4)	.22	1.3 (0.1)	1.5 (0.1)	.35
Diameter, mm	2.6 (0.1)	2.6 (0.2)	.74	2.3 (0.1)	2.3 (0.1)	.99
Flow, mL/min	118 (15)	73 (8)	.01	65 (6)	87 (5)	.01
Right ITA						
PSV, cm/s	57 (12)	50 (11)	.73	44 (4)	42 (4)	.34
EDV, cm/s	4 (2)	4 (2)	.67	6 (3)	6 (2)	.74
TAMV, cm/s	22 (4)	23 (9)	.50	20 (4)	18 (3)	.57
PI	2.4 (0.5)	2.0 (0.9)	.25	1.9 (0.1)	2.0 (0.2)	.07
Diameter, mm	2.4 (0.2)	2.5 (0.3)	.27	2.2 (0.3)	2.3 (0.1)	.29
Flow, mL/min	60 (11)	68 (14)	.54	46 (14)	45 (11)	.32
Left brachial artery						
PSV, cm/s	116 (45)	133 (42)	.28	134 (44)	112 (33)	.28
EDV, cm/s	22 (14)	43 (23)	.10	49 (25)	27 (18)	.07
TAMV, cm/s	59 (46)	69 (41)	.19	65 (6)	53 (16)	.12
PI	1.6 (0.5)	1.3 (0.4)	.16	1.3 (0.1)	1.6 (0.1)	.01
Diameter, mm	3.7 (0.8)	3.8 (0.7)	.72	3.7 (0.6)	3.7 (0.5)	.90
Flow, mL/min	380 (25)	469 (78)	.01	419 (32)	342 (23)	.01

*Data are presented as the mean (SD). ITA indicates internal thoracic artery; PSV, peak systolic velocity; EDV, end-diastolic velocity; TAMV, time-averaged mean velocity; PI, pulsatility index.

unpaired 2-tailed Student *t* test. The significance level of the *P* value was set at 5%. All statistical analyses were performed with the SPSS statistical package (version 11.0; SPSS, Chicago, IL, USA).

RESULTS

Detailed results of the Doppler echocardiography measurements are summarized in the Table. A biphasic pattern (systolic and diastolic) was recorded in all cases. When the hemodialysis pump was started, there was a significant reduction in the flow of the left ITA ($P = .01$), whereas there was no variation in the right ITA flow ($P = .54$). During dialysis, no patients experienced hypotension, arrhythmia, or angina. Just after the end of dialysis, the flow of the left ITA increased significantly ($P = .01$).

DISCUSSION

The major finding of the present study is that the flow of the ITA graft ipsilateral to an upper-extremity arteriovenous fistula is reduced during postoperative hemodialysis, even when the ITA is harvested with the skeletonization technique.

Some investigators have demonstrated a reduction in the flow of an ITA graft ipsilateral to an arteriovenous fistula during postoperative hemodialysis [Crowley 2002; Gaudino 2003; Kato 2003]. Gaudino and colleagues used transthoracic Doppler echocardiography to directly evaluate flow variation in a pedicled ITA ipsilateral to an arteriovenous fistula and demonstrated a reduction in ITA flow concomitant with the start of the dialysis, a reduction in anterior left ventricular wall motion, and a reduction in angina during the dialysis period. Our results are in agreement with their report on flow reduction of the ipsilateral ITA. Although we do not have any data on left ventricular wall motion during dialysis, no patients had angina in our study.

In a report on the effect of graft flow in the skeletonized ITA, Takami et al [2002] demonstrated that skeletonization of the ITA makes it possible to anastomose the ITA with a larger diameter, leading to an increased perioperative graft flow by decreasing the vascular resistance. Although we cannot make a definitive conclusion from our results because we did not directly compare flow variation for the skeletonized ITA and the pedicled ITA, the lack of angina in our study might be attributed to the skeletonization technique.

The present study has important limitations. First, variations before and after commencement of the dialysis pump with respect to circulating volume, systemic vascular resistance, cardiac output, and blood pressure made accurate evaluation of graft flow difficult; however, the fact that the ipsilateral ITA flow decreased during the dialysis period despite the absence of a significant reduction in flow of the contralateral ITA may have some clinical value. Second, our study population was small, which led to insufficient reproducibility of the Doppler echocardiography results. In our study, all measurements were performed by a single physician and repeated at least 5 times, but the Doppler echocardiography results were still observer dependent. Third, the lack of available data on the pedicled ITA did not allow us to compare the flow variation for the skeletonized ITA and the pedicled ITA.

CONCLUSION

Reduction in the flow in the ITA graft ipsilateral to an upper-extremity arteriovenous fistula develops during postoperative hemodialysis, even when the skeletonization technique is used. Clinically, this result may be useful in developing the grafting strategy.

REFERENCES

Crowley SD, Butterly DW, Peter RH, Schwab SJ. 2002. Coronary steal from a left internal mammary artery coronary bypass graft by a left upper extremity arteriovenous hemodialysis fistula. Am J Kidney Dis 40:852-5.

Crowley JJ, Shapiro LM. 1995. Noninvasive assessment of left internal mammary artery graft patency using transthoracic echocardiography. Circulation 92(suppl):II25-30.

De Bono DP, Samani NJ, Spyt TJ, Harshorne T, Thrush AJ, Evans DH. 1992. Transcutaneous ultrasound measurement of blood-flow in internal mammary artery to coronary artery grafts. Lancet 339:379-81.

Gaudino M, Serricchio M, Luciani N, et al. 2003. Risks of using internal thoracic artery grafts in patients in chronic hemodialysis via upper extremity arteriovenous fistula. Circulation 107:2653-5.

Higami T, Kozawa S, Asada T, Shida T, Ogawa K. 2000. Skeletonization and harvest of the internal thoracic artery with an ultrasonic scalpel. Ann Thorac Surg 70:307-8.

Higami T, Yamashita T, Nohara H, Iwahashi K, Shida T, Ogawa K. 2001. Early results of coronary grafting using ultrasonically skeletonized internal thoracic arteries. Ann Thorac Surg 71:1224-8.

Kato H, Ikawa S, Hayashi A, Yokoyama K. 2003. Internal mammary artery steal in a dialysis patient. Ann Thorac Surg 75:270-1.

K/DOQI Workgroup. 2005. K/DOQI clinical practice guidelines for cardiovascular disease in dialysis patients. Am J Kidney Dis 45(suppl 3): S1-153.

Takami Y, Ina H. 2002. Effects of skeletonization on intraoperative flow and anastomosis diameter of internal thoracic arteries in coronary artery bypass grafting. Ann Thorac Surg 73:1441-5.

van Son JAM, Skotnicki SH, Peters MBM, Pijls NH, Noyez L, van Asten WN. 1993. Noninvasive hemodynamic assessment of the internal mammary artery in myocardial revascularization. Ann Thorac Surg 55:404-9.