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Effect of Proximal Anastomotic Diameter on Venous Bypass Graft Patency in Patients Undergoing Coronary Artery Bypass Grafting

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ABSTRACT

Background: In this study, the relationship between patency of saphenous vein (SV) graft and different sizes of aorta wall punches was investigated during the follow-up period after coronary artery bypass graft surgery. We also evaluated the other possible factors affecting SV graft patency.

Methods: This study consisted of 266 consecutive and symptomatic patients with postoperative angiography. The primary endpoint was at least one saphenous graft failure observed from coronary computed tomography angiography (cCTA) and/or invasive angiography after surgery. Groups were created as SV occluded and patent group. Survival curves of patients in groups were estimated using Kaplan-Meier method and compared by log-rank test. Multivariate analysis was performed using the Cox proportional hazard model.

Results: Cox-regression analysis demonstrated influence of older age ($P = .023$) and Diabetes Mellitus (DM) ($P = .002$) on SV graft failure. However, increasing ejection fraction ($P = .011$) was a protective factor against SV graft failure. There was no significant difference between the two groups in terms of usage rate of the punches with different diameters ($P = .296$).

Conclusion: The incidence of SV graft patency does not seem to increase in patients whose 4.8-mm aortic punch was used during proximal anastomosis compared to the reference group in which a punch of 4.0 mm was used. Also, the final proximal anastomosis graft size that was measured using cCTA was similar between patients with 4.8-mm punch and patients with 4-mm punch. Results from this study could help to determine which size for aortosaphenous anastomosis is clinically optimal.

INTRODUCTION

The purpose of coronary artery bypass grafting (CABG) is to obtain patency in all grafts during a patient's lifespan. The left internal thoracic artery (LITA) has better long-term patency compared to other grafts including saphenous vein (SV) grafts, radial artery [Desai 2007]. It can be shown that many factors such as atherosclerotic processes, anastomotic features, and the magnitude of the vascular bed for run-off may be associated with the SV graft patency [Sarzaeem 2010].

As a different topic, the size of proximal anastomosis is constructed to match the proximal graft size. A biological mismatch between the aortic hole and the graft size is always present but macroscopically minimal because surgeons try to minimize the mismatch. Although the proximal vein is beveled to allow laminar flow that increases patency rate of grafts, there is no detailed available data to suggest a more reasonable treatment selection between the punch hole sizes.

In this study, predictors of the SV graft failure and influence of the different punch holes made in the aortic wall on graft patency were investigated.

MATERIALS AND METHODS

This study consisted of 266 consecutive and symptomatic patients with postoperative angiography after isolated on-pump coronary artery surgery using SV graft from August 2009 to April 2012. 1980 patients had undergone CABG in the range of this last mentioned date. As a protocol of our hospital, all patients who undergo CABG surgery are controlled systematically irrespective of symptoms with certain date ranges. The cohort of studied 266 consecutive patients with their coronary angiography was selected out of the 1980 who underwent CABG during the study period. Groups were created retrospectively according to the failure of at least one proximal aortosaphenous anastomosis by coronary computed tomography angiography (cCTA) and invasive coronary angiography. The CT angiograms and coronary angiograms were performed depending on both clinical status and treadmill exercise test. The patients with stable angina symptoms and/or positive stress test results were first examined with cCTA in our hospital. Therefore, conventional coronary angiograms of patients with failure graft according to cCTA were planned electively.

The patient exclusion criteria were the use of different hole punchers in the same patient who had more than one proximal anastomosis, renal failure (serum creatinine [sCr] level >2.0 mg/dL), hematological disorders such as severe anemia (hemoglobin level <10 g/dL), concomitant valvular surgery,

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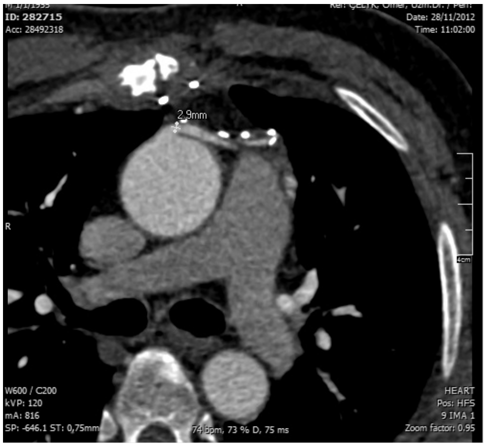


Figure 1. Computerized tomography angiography demonstrates how to measure the final proximal anastomosis graft size

emergency, congenital heart disease, and without regular follow-up period, taking medical treatment consisting of statin and beta blocker. Off-pump patients were also excluded. All patients received statin and low-dose aspirin during their follow-up period. SV graft failure within the first year of surgery can be attributed to surgical technical errors [Sabik 2011]. But it could be due to thrombosis or intimal hyperplasia added to technical errors. Because of that, patients who were within a one-year follow-up period were not excluded from our study.

After approval of the institutional review board, the study was conducted in a retrospective design in our cardiovascular surgery clinic. This study was in accordance with Helsinki Declaration Guidance. This study was not supported by any company. An informed consent form was obtained from every single patient before enrollment.

Definition of Terms

Hypertension (HT) was defined as systemic blood pressure >140/90 mmHg or taking antihypertensive treatment. Cerebrovascular disease was included in those with a history of stroke, transient ischemic attack, or both. The presence of diabetes mellitus (DM) was self-reported or based on previous medical documentation. Body mass index was calculated from simultaneous measurements of height and weight. Ejection fraction (EF) was assessed by echocardiography (Vivid S6 with a 3.5 MHz phased array transducer, GE Medical System, Horten, Norway) using a modified Simpson's method.

Surgical Details

All patients in this cohort were operated by the same surgeons and anesthesia team. Anesthetic management was similar in all patients. We employed aortic-unicaval cannulation, standard cardiopulmonary bypass, and moderate systemic hypothermia in all patients. After aortic cross clamping, cardioplegic arrest was performed with isothermic blood cardioplegia. LITA was used for LAD bypass as a standard protocol in all patients, while all other anastomoses were performed using SV graft. If LAD coronary artery had consecutive stenosis, left coronary territory was revascularized by using both SVG and LITA. Lateral occluding clamp technique for the construction of proximal anastomosis was used in all patients. All distal anastomoses were constructed with continuous 7/0 polypropylene and performed in a similar fashion. Length of grafts was adjusted meticulously in order to avoid graft kinking or overstretching. All proximal anastomoses were carried out with continuous 6/0 polypropylene. In some patients, T-graft or sequential graft was used to minimize aortic manipulation. Sequential use of saphenous vein was a preferred approach in lateral and anterolateral side of heart anastomoses in cases. The aorta was carefully examined and punctured with a scalpel (no. 11) not to encounter

Table 1. Features of SV Graft Occluded and Patient Population*

Demographic	SV graft occluded group, n = 100	SV graft patent group, n = 166	*P*
Age, y	63.32 ± 8.15	57.98 ± 8.26	.0001
Male sex, n (%)	82 (82)	127 (76.51)	.290
Female sex, n (%)	18 (18)	39 (23.49)	
Body mass index, kg/m^2	27.92 ± 3.86	28.78 ± 4.14	.157
Current smoking, n (%)	62 (62)	55 (33.13)	.0001
Ejection fraction	45.58 ± 9.06	56.28 ± 6.95	.0001
SYNTAX score	27.91 ± 9.18	23.47 ± 9.95	.001
Total cholesterol level, mg/dL	208.77 ± 68.37	200.54 ± 55.81	.287
HDL, mg/dL	38.61 ± 10.46	39.5 ± 12.45	.549
LDL, mg/dL	133.4 ± 42.52	129.49 ± 45.82	.490
Trigliseride, mg/dL	235.39 ± 173.01	212.87 ± 152.19	.416
FPG, mg/dL	141.11 ± 63.78	135.54 ± 57.14	.463
Hba1c	7.24 ± 2.15	6.81 ± 1.75	.092
Hemoglobin, g/dL	13.77 ± 1.72	15.73 ± 27.67	.481
Platelet count, 1000 mL	254.18 ± 63.72	246.29 ± 71.60	.361
White cell count, × 10^9/L	9 ± 2.57	8.83 ± 2.73	.605
Serum creatinine level	1.11 ± 0.31	0.87 ± 0.2	.0001
Comorbidity (n, %)			
DM	69 (69)	70 (42.17)	.0001
HT	61 (61)	82 (49.40)	.066
PVD	6 (6)	11 (6.63)	.840
COPD	19 (19)	27 (16.27)	.586
History of CVA	3 (3)	2 (1.21)	.301
Previous MI	57 (57)	62 (37.35)	.002
Previous PCI	39 (39)	59 (35.54)	.571

*Data are presented as the mean ± SD where indicated. DM indicates diabetes mellitus; HT, hypertension; PVD, peripheral vascular disease; COPD, chronic obstructive pulmonary disease; CVA, cerebrovascular accident; MI, myocardial infarction; PCI, percutaneous coronary intervention.

Table 2. Native Coronary Artery Disease Data of the Study Population

Target artery	Target artery size	SV graft occluded group, n = 100 mean ± SD	SV graft patent group, n = 166 mean ± SD	*P*
LAD	Large	40 (41.67%)	94 (56.63%)	
	Medium	48 (50%)	68 (40.96%)	.047
	Small	8 (8.33%)	4 (2.41%)	
Diagonal	Large	6 (13.04%)	15 (17.65%)	
	Medium	39 (84.78%)	68 (80%)	.785
	Small	1 (2.17%)	2 (2.35%)	
Intermediary	Large	9 (69.23%)	10 (50%)	
	Medium	3 (23.08%)	10 (50%)	.174
	Small	1 (7.69%)	0	
OM1	Large	8 (25.81%)	7 (23.33%)	
	Medium	22 (70.97%)	22 (73.33%)	.975
	Small	1 (3.23%)	1 (3.33%)	
OM2	Large	22 (34.38%)	27 (27.84%)	
	Medium	38 (59.38%)	69 (71.13%)	.094
	Small	4 (6.25%)	1 (1.03%)	
RCA	Large	12 (52.17%)	24 (64.86%)	.236
	Medium	11 (47.83%)	11 (29.73%)	
	Small	0	2 (5.41%)	
RCA-pda	Large	7 (14.58%)	22 (28.21%)	
	Medium	38 (79.17%)	52 (66.67%)	.315
	Small	3 (6.25%)	4 (5.13%)	
RCA-pl	Large	1 (20%)	3 (33.33%)	
	Medium	3 (60%)	6 (66.67%)	.364
	Small	1 (20%)	0	
Proximal stenosis of target vessel				
LMCA		17 (17%)	21 (12.65%)	.326
LAD	70%-79.9%	10 (10.53%)	24 (15.29%)	
	80%-89.9%	29 (30.53%)	57 (36.31%)	.379
	90%-99.9%	33 (34.74%)	48 (30.57%)	
	100%	23 (24.21%)	28 (17.83%)	
Cx	70%-79.9%	16 (19.51%)	25 (20.66%)	
	80%-89.9%	30 (36.59%)	42 (34.71%)	.961
	90%-99.9%	23 (28.05%)	37 (30.58%)	
	100%	13 (15.85%)	17 (14.05%)	
RCA	70%-79.9%	15 (21.74%)	28 (24.14%)	
	80%-89.9%	22 (31.88%)	28 (24.14%)	.720
	90%-99.9%	16 (23.19%)	31 (26.72%)	
	100%	16 (23.19%)	29 (25%)	

LAD indicates left anterior descending; OM, obtuse marginal; RCA, right coronary artery; pda, posterior descending artery; pl, posterolateral.

Table 3. Surgical and Postoperative Data*

	SV graft occluded group, n = 100	SV graft patent group, n =166	*P*
Intraoperative variables			
Punch 4 mm, n (%)	67 (67)	100 (64.9)	.296
Punch 4.8 mm, n (%)	33 (33)	66 (39.76)	
Number of distal anastomoses	3.43 ± 0.83	3.14 ± 0.73	.004
Vein graft type, n (%)			
Sequential	9 (9)	8 (4.82)	.177
T graft	3 (3)	1 (0.6)	.121
Cardiopulmonary bypass time, min	103.09 ± 43.9	91.99 ± 32.82	.053
Cross clamp time, min	57.14 ± 36.92	49.79 ± 24.07	.106
Red blood cell units	3.72 ± 2.68	2.87 ± 2.24	.006
Usage of LITA, n (%)	99 (99)	158 (96.93)	.276
Postoperative variables			
POAF, n (%)	28 (28)	29 (17.58)	.045
Transient ischemic attack/stroke, n (%)	3 (3)	2 (1.21)	.301
Length of stay, d	9.56 ± 6.18	8.45 ± 2.86	.47
Use of clopidogrel, n (%)	14 (14)	13 (7.83)	.107
Interval from operation to CT angiogram, months	57.27 ± 36.06	52.35 ± 29.03	.223
Mortality, n (%)	0 (0)	0 (0)	

*Data are presented as the mean ± SD where indicated. LITA indicates left internal thoracic artery; PCI, percutaneous coronary intervention; POAF, postoperative atrial fibrillation.

atherosclerotic areas on the aorta because aortic wall without plaque provided both smooth edges and consistent size with punch hole and punch was being used once. The criterion of using 4.8-mm or 4.0-mm aortic punch was almost always dependent on the vein diameter. A 4.0-mm or 4.8-mm punch (Bıçakçılar rotating aortic punch device, Bıçakçılar, Istanbul, Turkey) was introduced into the hole.

Dual Source Computed Tomography (DSCT): Indication, Study Protocol, and Analysis

The cCTA protocol was performed using a DSCT with 2 × 128 detector rows equaling 256 slices (SOMATOM: Definition Flash Siemens Medical Solutions, Forcheim, Germany). cCTA were performed in 266 symptomatic post-CABG patients with the same DSCT protocol. All patients signed a written informed consent prior to DSCT.

Grafts were reviewed for patency and pathologic focal

Table 4. Multivariate Cox Regression Analysis for Duration of Patency in Months for Saphenous Vein Grafts

	Univariate Cox regression model				Multivariate Cox regression model			
			95% CI				95% CI	
	P	OR	Lower	Upper	*P*	OR	Lower	Upper
Age	.002	1.04	1.01	1.07	.023	1.03	1.01	1.07
EF value	.0001	0.94	0.92	0.98	.011	0.96	0.94	0.99
sCr level	.0001	5.21	2.85	9.54	.098	1.99	0.88	4.52
Number of distal anastomoses	.086	1.21	0.97	1.51				
Units of RBCs	.903	0.99	0.93	1.07				
Syntax score	.004	1.03	1.01	1.05	.128	1.02	0.99	1.05
DM	.0001	0.41	0.26	0.64	.002	0.46	0.27	0.76
Ongoing smoking	.003	0.53	0.35	0.80	.253	0.75	0.47	1.22
POAF	.318	1.25	0.80	1.95				

sCr indicates serum creatinine level; RBC, red blood cell; DM, diabetes mellitus; POAF, postoperative atrial fibrillation.

narrowing. Patients assessed by DSCT revealing evidence of graft occlusion or significant stenosis (greater than 60% of the graft diameter) were referred for further cardiologic investigation. Also, the final proximal anastomosis graft size was measured by using CT images in every case retrospectively (Figure 1). Two independent, blinded observers evaluated all grafts and measured the diameter of the proximal anastomosis. The angiographic findings from DSCT were assessed by two experienced readers to provide inter-observer variability.

Coronary Angiography and Coronary Artery Lesion Assessment

Angiograms of the native coronary arteries and bypass grafts as well as interventions were performed by interventional cardiologists with standard methods via femoral artery. Both LITA and each vein-to-aorta proximal anastomosis were given contrast media selectively. If the graft's location could not be found within the aorta, an aortic root injection was performed to find the orifice of graft or its stump. In skip vein grafts, every single segment was reviewed as a separate graft. All cine angiograms were reviewed by two cardiologists and a cardiac surgeon who were independent of this study and blinded to procedural data. For the per-graft end points of 70% stenosis and occlusion was accepted as a graft failure.

CAD complexity was assessed by the SYNTAX score [Serruys 2009]. Two cardiologists who also were blinded to the patient's clinical status and each other calculated SYNTAX score based on patient's coronary angiograms at the angiographic core laboratory. In case of disagreement, the opinion of a third observer was obtained.

Statistical Analysis

Statistical analysis was performed with NCSS 2007 statistical software (Number Cruncher Statistical System, Utah, USA). Continuous variables were summarized by mean ± standard deviation, and categorical variables as numbers and percentages. In order to determine the difference between the means of continuous variables, Student t-test for independent data was applied to normally distributed variables, while a Mann-Whitney U test was used for non-normally distributed variables. The chi-square test was used for independence between the two categorical variables.

A graft that can fail at any point after surgery due to the outcome of graft failure is time dependent. Therefore, univariable tests were used to prescreen covariates for inclusion in the regression model. In this analysis, outcome of SV graft failure was the dependent variable. A Cox proportional hazards regression model was used for analysis of time-to-event data due to open-ended follow-up time. First, the Kaplan-Meier survival estimates were calculated. Secondly, the possible factors identified with univariate analyses were further entered into the Cox regression analysis, to determine independent predictors of saphenous graft failure. Among correlated factors with similar effects on graft patency, only those with clinical significance were included. The inclusion and exclusion thresholds were set as 0.05.

There were no missing data. A *P* value of <.05 was considered statistically significant.

RESULTS

There were 266 cases undergoing CABG in both groups. The SV graft occluded group consisted of 100 patients with a mean age of 63.32 years while there were 166 patients with SV graft patent with a mean age of 57.98 years. Incidence of the SV graft failure was not affected by sex (*P* = .290). There were statistically significant differences between patients with occluded and patent grafts with regard to demographic features including age (*P* = .0001), ongoing smoking status (*P* = .0001), EF value (*P* = .0001), SYNTAX score (*P* = .001), sCr level (*P* = .0001), and DM (*P* = .0001) (Table 1). Proximal stenosis and sizes of target vessels were similar in patients between the two groups. Native coronary artery disease (CAD) data and target

Table 5. Comparison of the Final Proximal Anastomosis Graft Size Based on Puncher Type

	4.8-mm punch	4-mm punch	*P*
SV graft-LAD	3.58 ± 0.69	3.3 ± 0.99	.610
SV graft-Diag	3.07 ± 0.81	2.8 ± 0.94	.209
SV graft-IM	3.12 ± 1.02	2.57 ± 0.74	.266
SV graft-OM1	3.04 ± 1.12	2.88 ± 0.75	.789
SV graft-OM2	2.76 ± 0.85	2.9 ± 1.05	.507
SV graft-RCA	2.8 ± 0.87	2.62 ± 0.91	.403
SV graft-PDA	3 ± 0.68	2.58 ± 0.73	.072

LAD indicates left anterior descending artery; SV, saphenous vein; Diag, diagonal branch of LAD; OM, obtuse marginal branch of circumflex; RCA, right coronary artery; CX, circumflex artery; PDA, posterior descending artery of the RCA.

artery size are given in Table 2. Number of distal anastomoses, usage of red blood cell units, and rate of postoperative atrial fibrillation were significantly higher in patients with SV graft occluded than those in patients in the SV graft patent group (P = .004, P = .006, P = .045, respectively). Operative and postoperative data are given in Table 3.

Cox proportional hazards regression analysis was performed to assess the variables, considering the SV graft failure as a dependent variable in the study sample. The significance of older age (P = .023), DM (P = .002) and increasing EF (P = .011) persisted in this regression analysis (Table 4). Additionally, curves of the time-to-saphenous vein graft failure were similar between the two groups according to Cox regression analysis graph (Figure 2, A).

We also classified the study population into two groups according to aortic punches used during surgery to be able to evaluate the final proximal anastomosis graft size. According to the tomographic measurement, there was no statistically significant difference between patients with 4.0-mm and 4.8-mm grafts in view of diameter of final proximal anastomosis graft that were anastomosed to the coronary arteries in the LAD, CX, and RCA territories (Table 5). Additionally, there was no statistically significant difference in view of the cumulative patency rate of the SV graft between patients whose different punches were used (Figure 2, B). The cumulative patency rate of the SV graft in patients whose 4.8-mm punch was used was 97% at 1 year, 85% at 3 years, and 78% at 5 years after surgery, while patients whose 4.0-mm punch was used was 98% at 1 year, 85% at 3 years, and 68% at 5 years after surgery.

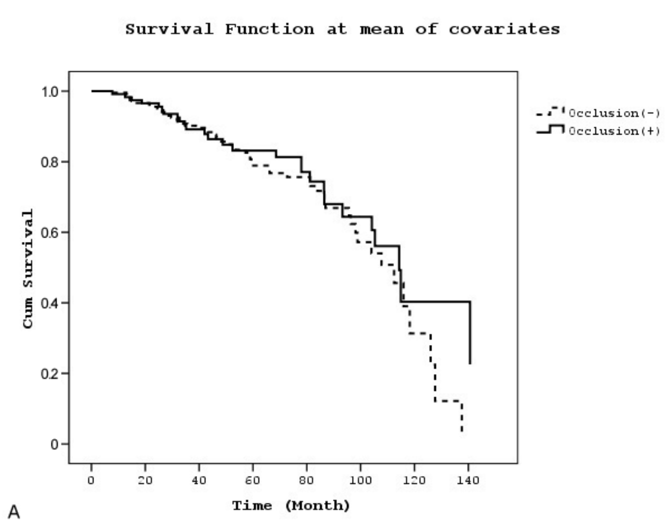
During the postoperative period PCI was performed in 13 patients (13%) with an occluded SV graft while in the patent group only 3 (1.81%) patients underwent PCI in their native coronary arteries. Conventional or direct stenting technique was applied in these patients according to their lesion characteristics.

The last angiography was performed on April 30, 2015 and this was about 3 years following surgery.

DISCUSSION

First, increasing EF is a protective factor against SV graft failure. Second, the decreased patency rate of the SV graft is associated with older age and DM. Third, there is no effect of broad proximal anastomotic diameter on venous bypass graft patency in patients undergoing CABG according to our study. Additionally, to the best of our knowledge, this is the first study evaluating the effect of different diameters of proximal anastomoses on the rate of SV graft patency.

Follow-up of CABG patients for graft patency and progression of CAD is necessary because there is the probability



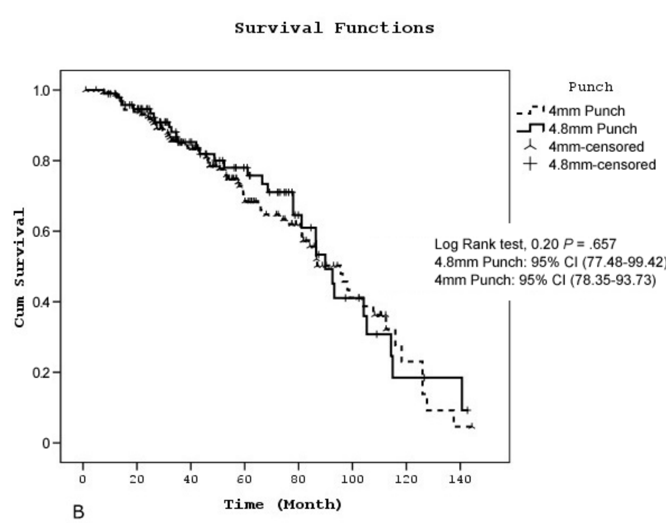


Figure 2. A, Cumulative patency rate of the SV graft by the Kaplan-Meier method.
B, The graph displays survival curves of the saphenous vein graft occlusion grouped by the time-to-event.

of graft restenosis. SV graft has the lower graft patency rate in comparison to LITA. In spite of this, it is still being utilized commonly as a conduit in CABG [Cho 2006]. Cho et al also suggests that patency rate of SV graft has steeply gradually sloped between the result of 5-year patency rate of SV graft and ten years [Cho 2006]. Therefore, influential factors of bypass graft patency are vital. One of these factors can be the state of the proximal SV graft anastomosis. Although much research on the hemodynamics at the distal anastomosis of bypass graft and target-vessel characteristics has been conducted, there has not been detailed information about the ideal diameter of the proximal anastomotic site and proximal artery flow condition including arterial conduits in the literature. It is well known that larger proximal graft anastomosis sites have better hemodynamic performance than smaller ones. As a matter of fact, 4-mm punch makes 12.56 mm^2 areas while the other one makes 18.08 mm^2 areas. Qiao et al reported that a larger or isodiametric graft is favorable because large grafts can bring about better hemodynamics with relatively large positive longitudinal velocity, uniform and large wall shear stresses, and small wall shear stress gradients [Nakajima 2011; Bonert 2002].

We do not think that our results are compatible with these reports in view of the effect of a 4.8-mm punch hole on the graft patency rate. Although the final proximal anastomosis graft size was larger in patients whose 4-8 mm punch was used than those in patients whose 4.0-mm punch was used, there was no statistically significant difference between groups created according to different punches that were used in patients in this study. The subject may be considered from another point of view. As a disadvantage, hemodynamic forces of the proximal artery flow may trigger the response of vascular endothelial cells that leads to the formation of intimal hyperplasia at the distal anastomosis and, ultimately, long-term graft patency [Kute 2001]. For this reason, surgeons may be inclined to exercise some control over the flow condition in the proximal artery by avoiding the use of broad aortic punch.

Another issue is that proximal artery flow condition can be affected by aggressive atherosclerotic narrowing beyond one year of surgery. As a result of this, occurrence of flow disturbance at the proximal anastomosis may jeopardize the patency along the rest of the SV graft. Obstructions of SV grafts can cause irreparable damages to the myocardium during the postoperative period. Therefore, proximal anastomosis may be as important as distal anastomosis. Native proximal artery flow condition (prograde, zero, and retrograde flow) may be another potent factor on the venous bypass graft patency. In other words, a partial stenosis of a bypassed coronary segment may allow residual forward flow through the native proximal coronary artery. Because of that we classified all coronary arteries according to their stenosis degree. But we did not observe any statistically significant difference between the two groups.

Although the proximal portion of SV grafts is almost always larger in diameter than 4-mm and commonly healthy enough for the anastomosis, this situation may not be the same for arterial conduits such as radial artery or free LITA. The circumference of the vein graft should be larger than the aortic hole; otherwise the hood of the vein may flatten and compromise the lumen. When the vein calibri is small, the aortic hole should be limited to avoid any mismatch between the vein graft and the aortic opening. For this reason, if the vein calibri is small, selection of the puncher may have to be oriented according to the sıze of the conduit. According to this, a surgeon may have to choose a 4-mm punch for proximal anastomosis to avoid size mismatch between the conduit and hole on the aorta. In addition, this preference may be valid for arterial conduits. But there are no comparative analyses planned using arterial conduits. Apart from that, reconstructing the anastomosis to suit one punch at 4.0-mm or 4.8-mm may not mean that the end anastomosis configuration was 4 or 4.8 but that to match the size of the aortic hole the vein could be anywhere between 2 and 6 mm, hoping that the proximal vein would be beveled to allow for laminar flow.

In some arteriosclerotic cases, to explore the aorta carefully before the proximal anastomosis may be important in view of anastomosis quality. In case of limited area on the surface of the aorta according to finger examination, a 4.0-mm punch may be more suitable for anastomosis. But, poorly placed stiches resulting in suture line stricture may lead to barely adequate coronary blood flow and reduce the anastomotic orifice thoroughly, in particularly for a diameter of 4-mm. For all these reasons, our findings may contribute to the search for the most appropriate punch-hole for proximal anastomosis.

SV graft diameter commonly has several folds larger than the target coronary artery, as we emphasized before. Therefore, it has plenty of flow to deliver unless the surgeon has created a problem. However, arteriolar resistance, by the vein or anastomosis, may limit its flow in the coronary artery system [Barner 2012]. In addition to these, a 2.0-mm coronary requires a 3.0 mm arteriotomy for a good match [Barner 2012]. Given the findings from cCTA regarding (the final proximal anastomosis graft size) diameter of proximal anastomosis in the follow-up period of surgery, using the 4-mm aortic puncher may be logical.

Although older age and DM are well-known predictive factors for SV graft failure, they are also non-specific factors [Yanagawa 2014; Zachrisson 2011]. Similarly, preserved EF can provide protection against SV graft failure but it is also a nonspecific factor in predicting SV graft patency [Shah 2003]. It can be explained that good runoff and wider viable myocardial areas need greater flow.

Limitations

Our study was a small and single center study. Another problem, retrospective review of operative notes and of the surgeon's techniques may be confounded by its descriptive accuracy as well as missing data. Therefore, our results should be confirmed in larger longitudinal prospective studies to obtain documentation of the graft patency studied at the time of surgery. In addition to this, graft flow measurement for each diameter of proximal anastomosis may require further research. Another concern is that DSCT scanners can provide a rapid and reliable noninvasive assessment of restenosis in CABG patients. But the CT angiogram analysis has less accuracy in detecting graft patency compared to the conventional coronary angiography, because scanning of a DSCT with 2 x 128 detector rows covers the whole heart in a short period of time. It is for this reason that improper timing of the scan can give rise to a false negative reading. Therefore, this can be thought of as a disadvantage in terms of graft evaluation.

Conclusion

From this study we conclude that use of the 4.8-mm punch or 4.0-mm punch is not an important part of the many influential factors in preventing SV graft failure looking at the results. In conclusion, we believe that our study's results may help surgeons in choosing the most appropriate aorta wall punch in their cases. Namely, use of a 4.0-mm punch for proximal aorta anastomosis may not jeopardize SV graft patency. The criteria of the selection of the aortic punch should be determined depending on the vein diameter.

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