



Current Status of cardiovascular surgery in Japan, 2015 and 2016: a report based on the Japan Cardiovascular Surgery Database. 2—Isolated coronary artery bypass grafting surgery

Aya Saito^{1,3} · Norimichi Hirahara² · Noboru Motomura¹ · Hiroaki Miyata² · Shinichi Takamoto²

Received: 14 March 2019 / Accepted: 11 June 2019 / Published online: 29 June 2019
© The Japanese Association for Thoracic Surgery 2019

Abstract

Data on isolated coronary artery bypass grafting (CABG) performed in 2015 and 2016, and registered in the Japan Cardiovascular Surgery Database were reviewed for preoperative characteristics, postoperative outcomes, and choice of graft material for the left anterior descending artery (LAD). Isolated CABG was performed off-pump in 55.0% ($n = 16,173$) of all CABG cases ($n = 29,392$), and graft material for the LAD was positioned at the internal thoracic artery in 72.1% and at the right internal thoracic artery in 17.4% of patients. Operative mortality was 1.7% in elective cases, 8.8% in emergency cases, and 3.0% overall, which was similar to our previous report. In elective cases, operative mortality was 1.1% for off-pump CABG compared with 2.5% for on-pump CABG, and all morbidities except for “readmission < 30 days” were significantly better in OPCAB cases.

Keywords Coronary artery bypass grafting · Off-pump coronary artery bypass grafting · On-pump coronary artery bypass grafting · Graft choice

Introduction

Coronary artery bypass grafting is still considered as a major open-heart surgery and yet, the number of cases is slowly decreasing over time because of the overflow of percutaneous coronary intervention (PCI) performance. Surgical cases are becoming more high risk, and recognizing the real clinical circumstances across the country will greatly assist individual surgeons to improve their clinical performance. This report presents the short-term clinical outcomes of isolated coronary artery bypass grafting (CABG) and detailed graft

choices of isolated CABG cases in the years 2015 and 2016 registered in the Japan Cardiovascular Surgery Database (JCVSD).

Patients and methods

Perioperative clinical data on isolated CABG were retrospectively reviewed. CABG procedures were performed from January 2015 to December 2016 and were registered in the JCVSD. Preoperative characteristics, frequency of single/bilateral internal thoracic artery (ITA) usage in combination with other types of grafts (radial artery [RA], right gastroepiploic artery [GEA], saphenous vein graft [SVG]), and graft choice for left anterior descending artery (LAD) revascularization were analyzed according to age. Dyslipidemia was defined as presenting, high low-density lipoprotein cholesterol levels (≥ 140 mg/dL), low high-density lipoprotein cholesterol levels (< 40 mg/dL), or high triglyceride levels (≥ 150 mg/dL). History of renal insufficiency was defined as presenting proteinuria, serum creatinine level ≥ 1.3 mg/dL, or estimated glomerular filtration rate < 60 mL/min/1.73 m². Chronic obstructive lung disease was defined as presenting percentage of forced expiratory

This is a secondary publication of the paper published in the *Japanese Journal of Cardiovascular Surgery* (Vol. 48, No. 1 pp 6–10).

✉ Aya Saito
ayasaitou-ths@umin.ac.jp

¹ Department of Cardiovascular Surgery, Toho University Sakura Medical Center, Chiba, Japan

² Department of Health Policy and Management, Keio University, Tokyo, Japan

³ JCVSD C/O The Japan Society for Cardiovascular Surgery, 2-26-9 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan

volume in 1 s of < 75%, bronchodilator or steroid use, partial pressure of oxygen of < 60 mmHg, or partial pressure of carbon dioxide of > 50 mmHg. Short-term clinical outcomes (operative mortality and morbidity) were investigated by categorizing patients based on age and cardiopulmonary bypass intervention. Operative mortality was defined as in-hospital mortality and/or 30-day mortality. Morbidities included incidence of postoperative bleeding, stroke, deep sternal infection, prolonged ventilation exceeding 72 h, pneumonia, atrial fibrillation (AF), gastrointestinal (GI) complications, and readmission within 30 days after surgery. The two groups were compared using the Chi-square test, with *p* values of < 0.05 defined as statistically significant.

Results

Preoperative characteristics of the overall cohort are presented in Table 1. The total number of patients included in the study was 29,395 biannually. This number was slightly lower than the previous biannual report reporting 31,987 cases [1]. There were no significant changes in other characteristics of preoperative conditions, such as male dominancy

Table 1 Preoperative characteristics of the patients (*n* = 29395)

	<i>n</i>	%
Male	23252	79.1
Obese	6685	22.7
Smoking	15117	51.4
Family history	2777	9.4
Diabetes	15811	53.8
Dyslipidemia	18626	63.4
Hypertension	22708	77.3
COPD	4288	14.6
Cerebrovascular disease	3478	11.8
Renal insufficiency	8431	28.7
Hemodialysis	3205	10.9
Arrhythmia (Af/AF)	1473	5.0
Extracardiac arteriopathy	5048	17.2
Surgery on PAD/AAA	1326	4.5
NYHA III,IV	6193	21.1
OMI	7258	24.7
AMI	3904	13.3
Unstable angina	9828	33.4
History of PCI	7379	25.1
Stent thrombosis	475	1.6
Indication of CABG in relation to PCI		
PCI complication	423	1.4
PCI failure w/o clinical deterioration	872	3.0
PCI/CABG hybrid procedure	685	2.3
Clinical other than above	27415	93.3

(79.1%), 53.8% diabetic patients, high rate of patients 10.9% with end-stage renal failure on hemodialysis, and 25.1% of patients with previous PCI.

Table 2 presents case distributions by age and graft choices based on the pattern of ITA use (single ITA use, SITA/bilateral ITA use, BITA/ITA use not clearly identified from the database, unclear) in combination with other types of grafts (saphenous vein graft [SVG], radial artery [RA], right gastroepiploic artery, [GEA]). Table 2 reports the age distribution and graft choice for elective surgery. The number of patients was slightly shifted towards older-aged individuals, with 50.5% (*n* = 12,309) performed in individuals over the age of 70 years, compared to 45.4% (*n* = 12,548) in the previous biannual report. The frequency of ITA use (SITA or BITA) was almost similar in cases below 60 years of age (SITA = 1908 cases, BITA = 1895 cases). BITA use was slightly more often in individuals over 60 years of age than in the previous report, with a SITA/BITA ratio of 12095/7323 individuals (ratio 1.65) compared to 13208/7473 individuals (ratio 1.77) in a previous report. All arterial graft use for all age groups was also investigated and showed an increase (all arterial grafting with SITA, 19.6% [*n* = 2740/14003] of all SITA use and BITA grafting use 36.0% [*n* = 3319/9218] of all BITA use) from previous report (all arterial grafting with SITA 17.5% [*n* = 2668/15272] and BITA 32.9% [*n* = 3202/11258]). Table 3 presents the data for emergency urgency cases. Naturally, the frequency of BITA use in emergency situations was lower than in elective cases: BITA use in elective and emergency/urgency was 37.8% and 25.5%, respectively; however, BITA use was more favored than in the previous report for all age groups.

Table 4 shows the graft choices for LAD revascularization stratified according to age. Candidate grafts were LITA, RITA, RA, GEA, and SVG. LITA was most frequently used in 76.1%, followed by RITA (18.4%), and SVG (5.0%). RA (0.5%) and GEA (0.1%) were used in very limited cases.

Operative mortality and immediate postoperative morbidity rates are presented in Table 5 along with a comparison between off-pump CABG (OPCAB) and on-pump CABG (ONCAB). OPCAB was performed in 55.0% of all isolated CABG cases (*n* = 16,173), and case number itself was stable from the previous report. The incidence of major morbidities presented in the same range as previous report, with 1.7% reoperation for bleeding requiring re-exploration, 1.7% stroke, 1.5% deep sternal infection, 3.4% renal insufficiency, 5.2% prolonged ventilation of more than 72 h, 2.5% pneumonia, 1.2% gastrointestinal tract complications, and 12.4% AF. Readmission within 30 days after surgery was observed in 0.5%, which was lower than in the previous report (1.9%), and operative mortality was 3.0%. Respective comparison of mortality and each morbidities rates between ONCAB and OPCAB by elective cases and emergency/urgent cases indicated that all types of complications were lower for

Table 2 Graft choice for elective operations

Age (year)	Overall		SITA				BITA				Unclear				
	n	%	Total SITA		w/o SVG (all arterial)		w/ SVG		Total BITA		w/o SVG (all arterial)		n	%	
			Sole	w/RA	w/GEA	w/RA+GEA	Sole	w/RA	w/GEA	w/RA+GEA					
n	24356		14003	11263	1600	422	404	124	9218	5899	1733	606	806	67	1135
~ 49	n	1175	559	347	123	31	42	16	561	311	108	69	65	8	55
	%		48%						48%						5%
50–59	n	2778	1349	1021	156	64	67	25	1334	809	242	95	149	23	95
	%		49%						48%						3%
60–69	n	8094	4327	3451	465	155	146	51	3453	2217	635	235	303	26	314
	%		53%						43%						4%
70–79	n	9359	5703	4737	584	144	123	27	3206	2138	592	181	243	10	450
	%		61%						34%						5%
80 ~	n	2950	2065	1707	272	28	26	5	664	424	156	26	46	0	221
	%		70%						23%						7%

Table 3 Graft choice for emergency/urgency cases

Age (year)	Overall		SITA				BITA				Unclear				
	n	%	Total SITA		w/o SVG (all arterial)		w/ SVG		Total BITA		w/o SVG (all arterial)		n	%	
			Sole	w/RA	w/GEA	w/RA+GEA	Sole	w/RA	w/GEA	w/RA+GEA					
n	5332		3325	2882	260	75	50	12	1358	828	313	91	109	3	649
~ 49	n	259	131	102	18	4	5	2	100	53	24	11	12	0	28
	%		51%						39%						11%
50–59	n	549	282	227	28	13	5	2	225	138	42	22	19	0	42
	%		51%						41%						8%
60–69	n	1451	894	768	65	29	16	3	417	250	96	27	38	3	140
	%		62%						29%						10%
70–79	n	2031	1317	1162	88	23	18	5	469	297	110	27	29	0	245
	%		65%						23%						12%
80 ~	n	1042	701	623	61	6	6	0	147	90	41	4	11	0	194
	%		67%						14%						19%

Table 4 Graft selection to LAD revascularization

		Graft selection for LAD revascularization					Unclear	Total
		LITA	RITA	RA	GEA	SVG		
		<i>n</i> = 21217	<i>n</i> = 5127	<i>n</i> = 139	<i>n</i> = 22	<i>n</i> = 1381	<i>n</i> = 1506	<i>n</i> = 29392
By age	~ 50	72.2%	17.4%	0.5%	0.1%	4.7%	5.1%	100.0%
		1010	279	6	0	43	92	1430
	50–59	70.6%	19.5%	0.4%	0.0%	3.0%	6.4%	100.0%
		2335	669	19	3	87	181	3294
	60–69	70.9%	20.3%	0.6%	0.1%	2.6%	5.5%	100.0%
		6722	1890	48	11	339	447	9457
	70–79	71.1%	20.0%	0.5%	0.1%	3.6%	4.7%	100.0%
		8210	1856	50	7	547	592	11262
	80 ~	72.9%	16.5%	0.4%	0.1%	4.9%	5.3%	100.0%
		2940	433	16	1	365	194	3949
		74.4%	11.0%	0.4%	0.0%	9.2%	4.9%	100.0%

OPCAB than ONCAB (e.g., operative mortality was 1.1% for OPCAB; whereas 2.5% for ONCAB in elective cases ($p < 0.001$), and 4.0% and 12.9% ($p < 0.001$), in emergency and urgent cases).

Comment

The Committee of the Society of Thoracic Surgeons National Database updates their trends of surgery and clinical results as executive summaries on their society's homepage (https://www.sts.org/sites/default/files/documents/ACSD_ExecutiveSummary2017Harvest4_RevisedReport.pdf), and has also published their 2016 annual report in 2017 [2]. Overall in-hospital and operative mortalities were reported to be 1.8% and 2.2%, which indicated better results compared to the operative mortality (3.0%) in the present report. It should be mentioned that the definition of the “mortality rate” needs to be carefully understood. In the STS annual reports, operative mortality usually exceeds in-hospital mortality. This would occur in our country since the duration of hospital stay is generally longer than the United States due to differences in the healthcare system, and in-hospital mortality usually includes both operative mortality, with in-hospital mortality > operative mortality. Our result evaluating the incidence of mediastinitis (1.5%) was apparently higher than in the STS report (0.3%). An increase in BITA use might have affected this relatively high rate of mediastinitis along with necessity for intensive wound care and blood sugar control; however, differences in the timing of discharge and onset of mediastinitis may have affected this result. Postoperative AF was less frequent in our data than in the STS report. Differences in the expected duration of hospitalization may affect short-term results from several standpoints, and further information on the duration

of hospitalization and duration until operative death may provide more precise understanding our results as well as of reports from other countries.

The present report time indicated an increase of RITA choice for LAD revascularization for both elective and emergency/urgency cases. There is an ongoing discussion on the benefits of RITA use for LAD [3, 4], and this phenomenon should be investigated.

In this report, postoperative results were better for OPCAB patients than for ONCAB patients, regardless of the situation (elective or emergency/urgency) for almost all aspects except for the readmission rate, which was similar for OPCAB and ONCAB. The OPCAB has been reported to be stably performed around 60% among the isolated CABG cases in our country, and 62.8% of the isolated CABG were performed by OPCAB in 2015 (8685 OPCAB/13,830 isolated CABG) by the JATS report [5]. The OPCAB occupied 54.7% of all the isolated CABG described in our last report [1], and was 55.0% this time. Number of OPCAB cases reported by JATS and by our report did not match, probably because JATS reports [5, 6] have been analyzed based on the survey information; whereas our report is based on the registered data to national clinical database, which covers cases from 599 cardiovascular units, thus the data source is different. The Dominancy of OPCAB among isolated CABG is closely associated with the patient's preoperative condition, severity of coronary artery lesions. It is also associated with frequency and indication of PCI; thus, a periodical nationwide report on clinical results of PCI is expected to be launched. Currently, the Japanese Registry Of All cardiac and vascular Disease (JROAD) is the most reliable registry covering cardiovascular disease, and it reported in 2016 that elective PCI was performed in 192,774 cases and emergent PCI in 71,799 cases (data not published). These trends need to be followed over time to help decent understanding of

Table 5 Perioperative results

	Overall	Elective cases			Emergency + urgency cases			ONCAB vs OPCAB p value							
		ONCAB		Total	ONCAB		Total								
		10331	13729	24060	2891	2444	5335								
Operative mortality	889	3.0%	263	2.5%	155	1.1%	418	1.7%	373	12.9%	98	4.0%	471	8.8%	< 0.001
Bleeding	501	1.7%	217	2.1%	119	0.9%	336	1.4%	131	4.5%	34	1.4%	165	3.1%	< 0.001
Stroke	503	1.7%	174	1.7%	138	1.0%	312	1.3%	128	4.4%	63	2.6%	191	3.6%	< 0.001
Deep sternal infection	434	1.5%	166	2.2%	169	1.2%	335	1.4%	62	2.1%	37	1.5%	99	1.9%	0.103
Prolonged ventilation > 72 h	1530	5.2%	439	4.2%	192	1.4%	631	2.6%	682	23.6%	217	8.9%	899	16.9%	< 0.001
Pneumonia	736	2.5%	217	2.1%	196	1.4%	413	1.7%	227	7.9%	96	3.9%	323	6.1%	< 0.001
Renal failure	1003	3.4%	301	2.9%	252	1.8%	553	2.3%	336	11.6%	114	4.7%	450	8.4%	< 0.001
Af	3635	12.4%	1389	13.4%	1543	11.2%	2932	12.2%	431	14.9%	272	11.1%	703	13.2%	< 0.001
GI complication	354	1.2%	124	1.2%	107	0.8%	231	1.0%	85	2.9%	38	1.6%	123	2.3%	0.001
Readmission < 30 days	157	0.5%	54	0.5%	75	0.5%	129	0.5%	15	0.5%	13	0.5%	28	0.5%	1.000

trends in the number of surgical cases and frequency of cardiopulmonary bypass use.

As described above, it is difficult to compare the surgical results of one country with another, as was the case for our results and those of the STS, because of the vast discrepancy between social health care systems. The duration of hospitalization differs, and the timing of diagnosis of postoperative complications differs in relation to the timing of discharge, and thus, the numbers reported should not be compared under the same conditions, suggesting that there may be a risk of reporting an ‘outcome shift’ occurrence.

Conclusions

Short-term clinical outcomes of isolated CABG procedures in 2015 and 2016 were analyzed based on the data registered in the JCVSD, a nationwide clinical database. Graft choice, especially for LAD revascularization, showed slight shift towards RITA use than in the previous report and the short-term results were significantly improved for OPCAB over ONCAB. These trends are expected to be followed periodically for the purposes of feedback to clinical management for quality improvement using the CABG procedure.

In this annual report, we analyzed two years’ worth of data. In JCVSD, a penetration rate of participating hospitals all over Japan almost reached 100% in 2013.

We started writing the annual reports in 2014, when we were already lagging behind by 4 years. To catch up with the latest year, we combined and analyzed the data of two years. We have finished the report for the first two years (2013–2014) and are now preparing the same for 2015–2016. As we gradually catch up with the real-time year, we will analyze each year separately.

References

1. Saito A, Hirahara N, Motomura N, Takamoto S. Current status of cardiovascular surgery in Japan, 2013 and 2014: a report based on the Japan Cardiovascular Surgery Database (JCVSD): 3. Coronary Artery Bypass Surgery. *Jpn J Cardiovasc Surg.* 2017;46:195–8.
2. Jacobs JP, Shahian DM, D’Agostino RS, et al. The Society of Thoracic Surgeons national database 2017 annual report. *Ann Thorac Surg.* 2017;104:1774–81.
3. Buttar SN, Yan TD, Taggart DP, et al. Long-term and short-term outcome of using bilateral internal mammary artery grafting versus left internal mammary artery grafting: a meta-analysis. *Heart.* 2017;103(18):1419–26. <https://doi.org/10.1136/heartjnl-2016-310864>.
4. Janiec M, Dimberg A, Shafti TZN, et al. No improvements in long-term outcome after coronary artery bypass grafting with arterial grafts as a second conduit: a Swedish nationwide registry study. *Eur J Cardio Thorac Surg.* 2018;53:448–54.
5. Masuda M, Endo S, Committee for Scientific Affairs, The Japanese Association for Thoracic Surgery, et al. Thoracic and

- cardiovascular surgery in Japan during 2015. *Gen Thorac Cardiovasc Surg.* 2018;66:581–615.
6. Masuda M, Endo S, Committee for Scientific Affairs, The Japanese Association for Thoracic Surgery, et al. Thoracic and cardiovascular surgery in Japan during 2014. *Gen Thorac Cardiovasc Surg.* 2016;64:665–97.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.