Off-pump technique reduces surgical mortality after elective coronary artery bypass grafting in patients with preoperative renal failure

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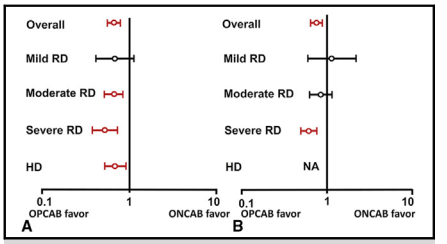
ABSTRACT

Objectives: Most randomized controlled trials of off-pump versus on-pump coronary artery bypass grafting (CABG) have included limited numbers of patients with preoperative renal failure. This study was performed to evaluate the association between the clinical benefit of the off-pump technique and chronic kidney disease stage.

Methods: We analyzed 38,051 patients with chronic kidney disease who underwent primary nonemergent isolated CABG from 2013 to 2015 as reported in the Japan Cardiovascular Surgery Database-Adult section. These patients were stratified into 4 categories according to their estimated glomerular filtration rate (eGFR) of 60 to 90, 30 to 59, and <30 mL/min/1.73 m^2, and hemodialysis-dependent. The clinical outcomes were compared between patients undergoing off-pump and on-pump CABG in each stratum using inverse probability of treatment weighting.

Results: In total, 23,634 (62.1%) patients were intended for off-pump CABG. In patients with mildly reduced renal function (eGFR 60–89 mL/min/1.73 m^2), there was no significant risk reduction effect of off-pump CABG for surgical mortality. Conversely, in patients with moderate or severe renal disease (eGFR <60 mL/min/1.73 m^2), off-pump CABG was associated with a significantly lower incidence of surgical death (odds ratio with 95% confidence interval: eGFR 30–59 mL/min/1.73 m^2, 0.66 [0.51–0.84]; eGFR <30 mL/min/1.73 m^2, 0.51 [0.37–0.72]; and hemodialysis-dependent, 0.68 [0.51–0.90]). In addition, in patients with severe renal disease (eGFR of <30), off-pump CABG was associated with a significantly lower incidence of de novo dialysis.

Conclusions: The off-pump technique significantly reduced surgical mortality in patients with moderate or severe preoperative renal dysfunction. (J Thorac Cardiovasc Surg 2018;156:976-83)



Propensity score-adjusted odds ratio for (A) surgical mortality and (B) de novo dialysis.

Central Message

The off-pump technique improves early mortality in patients with moderate or severe preoperative renal dysfunction.

Perspective

The association between the benefit of the off-pump technique and preoperative renal function remains unclear. In this large retrospective study, the mortality benefit of the off-pump technique was manifested in patients with moderate or severe renal dysfunction. This finding will help to identify patients who would benefit from the off-pump technique.

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Preoperative renal disease is a well known risk factor for adverse events after coronary artery bypass grafting (CABG).[1,2] A report from the Society of Thoracic

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Abbreviations and Acronyms

CABG = coronary artery bypass grafting
CKD = chronic kidney disease
eGFR = estimated glomerular filtration rate
GFR = glomerular filtration rate
IPTW = inverse probability of treatment weighting
JCVSD = Japan Cardiovascular Surgery Database
ONCAB = on-pump coronary artery bypass grafting
OPCAB = off-pump coronary artery bypass grafting
PCI = percutaneous coronary intervention
STS = Society of Thoracic Surgeons

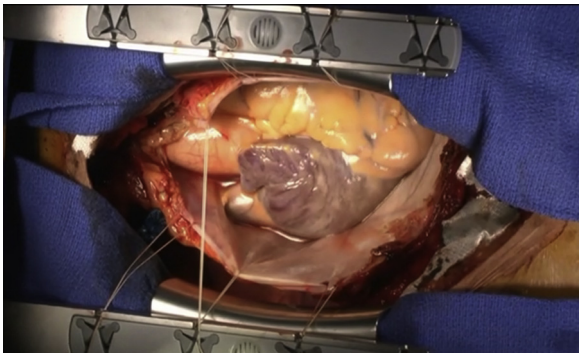
Surgeons (STS) national database stated that preoperative renal disease is common in patients who undergo CABG and that early mortality and morbidity after CABG rise inversely with declining preoperative renal function.[3]

Previous meta-analyses of randomized trials comparing off-pump CABG (OPCAB) and on-pump CABG (ONCAB) have failed to show the mortality benefit of OPCAB.[4-6] However, it has also been shown that the mortality benefit of OPCAB is significantly related to the risk profile of the enrolled patients.[4] In addition, multiple retrospective studies have shown the mortality benefit of OPCAB in high-risk patient cohorts (Video 1).[7-9] Therefore, it can be hypothesized that OPCAB is associated with a mortality benefit in patients with preoperative renal dysfunction. Most randomized trials have included limited numbers of patients with preoperative renal disease.[5] For example, a recent large randomized trial, the Randomized On/Off Bypass (ROOBY) trial, included only a small number of patients with an elevated serum creatinine concentration (8.5% in the OPCAB group and 7.2% in the ONCAB group).[10] Another recent large randomized trial, the CABG Off or On Pump Revascularization Study (CORONARY), also included only a limited number of dialysis patients (1.7% in the OPCAB group and 1.1% in the ONCAB group).[11] Consequently, most randomized trials could not evaluate the clinical benefit of OPCAB in patients with preoperative renal disease. A risk-adjusted retrospective study using a large data set is therefore needed to understand the association between the benefit of OPCAB and preoperative renal disease. This study was performed to determine the association between the clinical benefit of OPCAB and preoperative chronic kidney disease (CKD) stage using data from the Japan Cardiovascular Surgery Database (JCVSD).

METHODS

The JCVSD

The JCVSD was established in 2000 to evaluate surgical outcomes after cardiovascular procedures in hospitals throughout Japan. As of 2014, the JCVSD-Adult section had collected clinical information from more than 538 hospitals across Japan. More than 300 variables in the data collection form are nearly identical to those of the STS National Database. The content of the JCVSD-Adult section is available online at http://www.jacvsd.umin.jp. The methods of data collection from the JCVSD have been previously described.[1] The institutional review board at each participating hospital has approved the collection of their data for use in the JCVSD, and the Data Utilization Committee of the JCVSD approved the use of data for the present study. To date, data collection has achieved a high level of completion, with less than 3% of entries missing for overall preoperative risk factors used in risk models. In addition, the accuracy of submitted data is maintained by regular data auditing in which monthly visits are made to participating hospitals to check the reported data against clinical records. Data validity is further confirmed by independent comparison of specific hospitals' volume of cardiac surgeries entered in the JCVSD with that reported in the annual survey of the Japanese Association for Thoracic Surgery.[12] Further, from 2010 onward, the JCVSD served as part of the National Clinical Database in Japan, which includes clinician-initiated databases reflecting all surgical fields. By the end of 2013, the JCVSD had become a national database covering almost all cardiac procedures in Japan.



VIDEO 1. Off-pump coronary artery bypass grafting with skeletonized bilateral internal thoracic arteries for a patient with left main coronary disease. Video available at: https://www.jtcvs.org/article/S0022-5223(18)30934-6/fulltext.

Study Population

The data of patients included in the JCVSD-Adult section from January 1, 2013, to December 31, 2015, were analyzed. Patients with complete data on preoperative renal function who underwent primary nonemergent isolated CABG were included. The exclusion criteria were an emergent or salvage status, redo surgery, and preoperative cardiogenic shock. Records with missing data on age (or out-of-range age), sex, or 30-day status (see "Study End Points" for an explanation) were excluded. With the exception of the body surface area and preoperative creatinine concentration, all missing or out-of-range values were imputed using the variable-specific median value. Upon completion of this data cleaning procedure, 38,804 patients were detected. After excluding 753 patients with normal renal function (estimated glomerular filtration rate [eGFR] of $\geq$90 mL/min/1.73 m^2), 38,051 patients with CKD were included in the present study. These patients were stratified into 4 groups according to their most recently available preoperative eGFR, which was calculated from the Modification of Diet in Renal Disease equation: eGFR mL/min/1.73 m^2 = 194 $\times$ (serum creatinine level [mg/dL])$^{-1.094}$ $\times$ (age [years])$^{-0.287}$ $\times$ 0.739 (if female).[13] On the basis of the result, the patients were determined to have mild renal disease (eGFR = 60–90 mL/min/1.73 m^2; n = 7260), moderate renal disease (eGFR = 30–59 mL/min/1.73 m^2; n = 22,727), severe renal disease (eGFR <30 mL/min/1.73 m^2; n = 4098), or hemodialysis dependence (n = 3966). Because an intention-to-treat principle was applied to all statistical analyses, patients intended for OPCAB were included in the OPCAB group even if they were converted intraoperatively to ONCAB and vice versa.