

Coronary Artery Bypass Grafting in DES Era

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Coronary artery bypass grafting (CABG) has played an important role in the treatment of ischemic heart disease. Recently, the introduction of a drug-eluting stent (DES) has decreased the incidence of restenosis after percutaneous intervention (PCI). PCI with a DES is being increasingly performed, whereas the number of patients for whom CABG has been indicated has decreased over the last few years in Japan and the United States. According to a report, the number of patients undergoing CABG will not decrease in the future due to its usefulness in the treatment of multi-vessel lesions. We have also reviewed how CABG should be improved. For this purpose, it may be important to carry out less invasive CABG by the off-pump method and to improve the long-term results obtained by CABG with an internal thoracic artery graft and complete revascularization. Hence, CABG may achieve better long-term results compared with PCI and continued future application of CABG. (Ann Thorac Cardiovasc Surg 2007; 13: 5–8)

Key words: coronary artery bypass grafting, drug-eluting stent, off-pump coronary artery bypass grafting, complete revascularization

Introduction

Since coronary artery bypass grafting (CABG) was introduced in the 1960's, it has played an important role in the treatment of ischemic heart disease. Good long-term results, including those of follow-up over 20 years, have been published.^{1,2)} In the 1970's, Gruentzig initially reported on coronary reconstruction by percutaneous intervention (PCI). Currently, this procedure is mainly performed for coronary revascularization. Recently, the introduction of a drug-eluting stent (DES) has decreased the incidence of restenosis after PCI,^{3,4)} overcoming the limitation of PCI. Widespread DES usage may influence the role of CABG. Due to this, we have reviewed how CABG should be improved.

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Comparison of PCI Prior to the Introduction of a DES with CABG

Many studies have compared the long-term results of PCI with those of CABG in patients with multi-vessel lesions.

Malenka et al.⁵⁾ reviewed the Northern New England registries, and compared the long-term results between PCI and CABG. The adjusted long-term survival rate for patients with 3-vessel disease was better after CABG than PCI, but not for patients with 2-vessel disease. The survival advantage following CABG for 3-vessel disease patients was present in all patient populations, including women, diabetics, the elderly, and in the era of high stent utilization.

Hannan et al.⁶⁾ used New York's cardiac registries to identify 37,212 patients with multivessel disease who underwent CABG and 22,102 patients with multi-vessel disease who underwent PCI. They determined the rates of death and subsequent revascularization within 3 years after the procedure in various groups of patients according to the number of diseased vessels and the presence or absence of left anterior descending coronary artery involvement. The rates of adverse outcomes were ad-

justed by means of proportional-hazards methods to account for differences in patients' severity of illness before revascularization. Risk-adjusted survival rates were significantly higher among patients who underwent CABG than among those who received a stent in all anatomical subgroups studied. For example, the adjusted hazards ratio for the long-term risk of death after CABG relative to stent implantation was 0.64 for patients with 3-vessel disease with involvement of the proximal left anterior descending coronary artery and 0.76 for patients with 2-vessel disease with involvement of the nonproximal left anterior descending coronary artery. Also, the 3-year rates of revascularization were considerably higher in the stenting group than in the CABG group (7.8% vs. 0.3% for subsequent CABG, and 27.3% vs. 4.6% for subsequent PCI). For patients with 2 or more diseased coronary arteries, CABG is associated with higher adjusted long-term survival rates than stenting.

In a large-scale study (BARI study⁷⁾), CABG achieved a higher long-term survival rate compared with PCI in treated diabetic patients. Based on this finding, CABG is selected for diabetic patients. The results of other large-scale studies also suggested that CABG was more useful than PCI.⁵⁾

Introduction of a DES and Its Effects on CABG

To elevate the topical concentration of an agent that inhibits proliferation of the intima, which is an etiological factor for restenosis, a DES, in which a stent is used as a platform for the agent, was developed. Currently, many agents are being evaluated as candidates. However, in commercially available models, sirolimus (Cypher) and paclitaxel (TAXUS) are used. The application of DESs with Cypher and TAXUS has inhibited neogenesis of the intima after stent insertion, decreasing the incidence of restenosis. Thus, the rate of additional intervention of the target coronary artery and the incidence of recurrent angina pectoris were lower than the values for a conventional bare metal stent (BMS). PCI with a DES is being increasingly performed, whereas the number of patients for whom CABG has been indicated has decreased over the last few years in Japan and the United States.^{8,9)}

However, there were no differences in the cardiac death-free or myocardial infarction-free rates 3 years after surgery between the DES and BMS groups. DES introduction decreased the incidence of restenosis after stent insertion, but not the incidences of myocardial infarction and cardiac death after several years.¹⁰⁻¹²⁾ DES introduction also prevented restenosis within 1–2 years, but the

terminal goal of treatment, an increase in the survival rate, has not been achieved. In this type of stent, a polymer is used to fix the agent. However, even after the agent is completely released, the polymer may remain and cause inflammation, leading to restenosis. Furthermore, acute/chronic thrombotic occlusion has been reported, indicating DES limitations.^{13,14)} In the future, the long-term results of DES usage should be investigated.

Several studies compared the long-term results between CABG and PCI with a DES: off-pump CABG in the left anterior descending artery vs. PCI with a DES, and CABG with bilateral internal thoracic artery grafts vs. PCI with a DES in patients with multi-vessel lesions. According to these studies, CABG achieved better long-term results including angina-free survival and intervention-free survival.^{15,16)} Concerning the influence of the widespread use of a DES on CABG, some studies speculated that the number of patients for whom CABG is indicated would not decrease in the future due to its usefulness in the treatment of multi-vessel lesions.^{17,18)}

We cannot conclude whether widespread DES usage will decrease the number of patients for whom CABG is indicated, and whether the effects of a DES persisting for only a few years after implantation will again increase the number of patients for whom CABG is indicated. However, future changes should be investigated, considering that the long-term results of DES usage will be reported in the future, and that new DES types other than Cypher will be developed.

Future CABG Strategies and the Application of Off-Pump CABG

DES introduction will improve the quality of PCI. In this state, we must review how future CABG strategies should be established.

One strategy is to make CABG less invasive. The off-pump method is useful for achieving less invasive CABG.¹⁹⁾ According to data collected by the Japanese Association for Coronary Artery Surgery, the off-pump method was employed in 60% of patients who underwent CABG in Japan in 2005²⁰⁾; This method is commonly used in Japan. In North America, the proportion of patients undergoing the off-pump method is approximately 15%; there is no increasing tendency.²¹⁾ The usefulness and widespread use of the off-pump method markedly differ between Japan and North America. The off-pump method is not commonly employed in North America because of a small number of bypass vessels and incomplete revascularization.²¹⁾

Furthermore, a study which compared 59,044 patients who underwent on-pump CABG with 9,135 patients who underwent off-pump CABG in 34 hospitals in the New York State, reported that the incidence of cardiac events several years after surgery was higher in the off-pump CABG group.²²⁾ This was a multi-center study, and the involvement of many surgeons who were not skilled in the off-pump method may have contributed to incomplete revascularization and cardiac events in the late phase. Caputo et al. divided patients who underwent off-pump CABG into 2 groups: complete and incomplete revascularization groups. They compared long-term results, and reported that the incidence of cardiac events in the late phase was higher in the incomplete revascularization group, suggesting the importance of complete revascularization.^{23,24)} In the off-pump method, complete revascularization may also be of utmost importance for improving long-term results. The choice of off-pump CABG should not limit the number of bypass vessels. Complete revascularization is essential to both off-pump and on-pump CABG.

Another strategy is to utilize the merits of CABG. CABG achieves better long-term results compared with PCI.^{1,2,5-7)} If this merit is maintained, it may contribute to the future application of CABG.

CABG achieves better long-term results because an internal thoracic artery graft, with a high patency rate in the late phase, is used, and because complete revascularization is performed. Internal thoracic artery bypass grafts have been demonstrated to remain patent over 20 years after surgery.¹⁾ Anastomosis of the internal thoracic artery, with the highest patency rate, to the most important coronary artery, the left anterior descending artery, is the golden standard. A study also indicated the late-phase patency of a radial artery graft.²⁵⁾ Another study reported a factor involved in the late-phase patency of a great saphenous vein graft.²⁶⁾ Complete revascularization considering graft features may further improve long-term results. In the future, PCI with a DES will advance, and CABG must be further improved.

Conclusion

DES introduction will transiently decrease the number of patients for whom CABG is indicated. For future application, less invasive off-pump CABG and CABG with an internal thoracic artery graft and complete revascularization for improving long-term results may be important.

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