Editorial

Evaluation of the Coronary Artery Bypass Graft

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It is thirty-five years since the initial coronary artery bypass graft (CABG) was performed in Japan in 1970.[1] There was more risk in surgery in the early days, and many efforts have been made to decrease the mortality rate. Since the 1980's when I was training to be a heart surgeon, surgical outcomes have improved, and the number of surgical cases has been steadily increasing. Since the long-term outcomes are good, the arterial graft is frequently used, and off-pump CABG is most frequently utilized because of its low invasiveness.[2] Evaluation of patency and blood supplying ability of bypass grafts is very important for CABG regardless of the graft type or surgical method, CABG is functional surgery; not perfomed for healing constrictive lesions of the coronary arteries.

After introduction of the bypass graft in Japan, palpation of pulsation with hands or measurement of blood flow using a very inaccurate electromagnetic flowmeter was used as an intraoperative evaluation of bypass graft. These methods were not capable of determing if an anastomosis was successful. Postoperative graft angiography was the only reliable method of graft evaluation at that time. However, graft angiography was performed after completion of surgery, and thus, only the results of surgery were evaluated.

Re-operation cannot be perfomed immediately after surgery, even if the likely outcome is poor. Moreover, angiography investigates only the patency and the condition of the anastomosed region by imaging, and sufficient functional evaluation of the graft cannot be obtained. The method, in which, Cardiogreen dye is injected into a venous graft during surgery, and the speed and area of staining are visually determined to judge if the surgery was successful, were one of the intraoperative evaluation methods. However, this method is not applicable for arterial grafts. The judgement relies on the subjective assessment of the surgeon, and it is not quantifiable. Thus, the method was not reliable with regard to functional evaluation.

As stated, CABG is functional surgery that reduces myocardial ischemia, and judgement of the success of surgery requires a postoperative load test, appropriate to the function of the graft, although this test may not satisfy surgeons.

None of the above methods, including currently performed postoperative angiography (CAG or Multi detector CT), provide adequate information for a graft evaluation method.

Infrared camera (IRIS-IV), SPY system, 1.5MHz fast echo method, and Doppler flow meter assessment were presented as intraoperative evaluation methods at a recent meeting.[3] The former two methods evaluate grafts by imaging to show coronary artery perfusion through the anastomosed graft. Although confirmation by imaging is convincing, functional evaluation of the graft is not sufficient. The fast echo method is capable of evaluating patency and function of grafts, but training is necessary for surgeons to acquire images during a grafting procedure.

The measurable regions are limited, which is a major disadvantage.

A Doppler flow meter is capable of measuring grafts in any region, and the measurement is simple. Accumulation of data has allowed prediction of patency of grafts when the blood flow is higher than a specified level.[4]

However, whether the graft exhibits good blood flow cannnot be judged. Although all of these evaluation methods guarantee patency of the graft, evaluation of function of the graft is not adequate.

CABG surgeons wish to confirm: 1) the absence of any error in anastomosis, 2) appropriateness of the anastomosed sites, and 3) capability of the graft to supply sufficient blood to perfused regions. A system capable of evaluating capability of grafts may be necessary, in addition to evaluation by imaging, for confirmaion of these factors. We have recently prepared a mathematical model

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specific to individual patients using the delta operator parameter identification method. A method of functional evaluation of grafts is currently under investigation. Surgeons can obtain waveforms displayed on a computer screen by measuring the bypass flow using an ultrasonic flow meter. Since these investigations allow measurement of graft resistance and compliance, which have previously been difficult to measure, blockage of blood flow can be detected during surgery. Data are being collected, and the limits of resistance and compliance for anastomosis will be clarified in the near future. This may allow the evaluation of graft function during surgery. In addition, preparation of a mathematical model specific to individual patients will be possible. Exercise and resting conditions will be established using arterial pressure and heart rate, and the reserve capacity of bypass grafts will be predicted based on the calculated blood flow and waveforms. Genomic analysis will lead the way to customized surgical care. Preparation of individualized data for surgery and postoperative follow-up will also allow evaluation of the CABG.

References

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