meta-analyses^{1,2} included nonrandomized observational studies, data of unadjusted crude mortality were abstracted and combined. In contrast, our preliminary meta-analysis³ of adjusted risk estimates from nonrandomized studies have suggested that DES use may increase mortality at 1 year or more relative to CABG for MVD. To assess whether DES treatment for MVD increases follow-up mortality relative to CABG, we updated our previous meta-analysis,³ combining not unadjusted but adjusted risk estimates.

Studies considered for inclusion met the following criteria: the design was a comparative study (randomized controlled trial or nonrandomized observational study); the study population was limited to patients with MVD; patients were assigned to DES or CABG treatment; and main outcomes included adjusted (in case of observational studies) hazard ratios (HRs), or odds ratios if HRs were unavailable, for all-cause mortality at 1 year and beyond. Our comprehensive search (current through January 2011) identified 2 randomized trials^{4,5} and 11 nonrandomized studies. We included 2 randomized trials (Coronary Artery Revascularization in Diabetes trial [CARDia]⁴ and Synergy between Percutaneous Coronary Intervention with Taxus and Cardiac Surgery trial [SYNTAX]⁵), although they included complex single-vessel disease (6.9%) and left main coronary artery disease without MVD (12.7%), respectively. We abstracted 2 unadjusted HRs from randomized trials and 18 adjusted HRs and 1 adjusted odds ratio from nonrandomized studies. Pooled analysis of all the 21 risk estimates demonstrated a statistically significant 24% increment in mortality with DES treatment relative to CABG in a random-effects model (HR, 1.24; 95% confidence interval, 1.02–1.50; $P = .03$; Figure 1). There was significant between-study heterogeneity ($P = .003$) but little difference in the pooled result from fixed-effects modeling

(HR, 1.25; 95% confidence interval, 1.12–1.39; $P < .0001$). When 7 HRs in double-vessel disease and 8 HRs in triple-vessel disease were pooled separately, DES treatment was associated with, respectively, a statistically nonsignificant 27% and a 36% increment in mortality relative to CABG. Eliminating the 2 randomized trials^{4,5} that included a few with single-vessel disease or left main coronary artery disease without MVD did not substantially change the pooled point estimate (random-effects HR, 1.25; 95% confidence interval, 1.005–1.55; $P = .045$). There was no evidence of significant publication bias ($P = .88$ by an adjusted rank-correlation test, $P = .96$ by a linear regression test).

Despite the results of the previous unadjusted meta-analyses, including that of Yan and collaborators,^{1,2} we found our current adjusted meta-analysis of mainly nonrandomized observational studies with a few randomized controlled trials to indicate that DES treatment for MVD may increase all-cause mortality at 1 year and beyond by 24% relative to CABG. CABG rather than DES treatment should therefore be considered for MVD, because follow-up mortality reduction must imply the greatest clinical benefit among patients with MVD. To cut the Gordian knot of DES versus CABG for MVD, however, additional randomized trials are needed.

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doi:10.1016/j.jtcvs.2011.02.042

Reply to the Editor:

We congratulate Takagi and colleagues on their updated meta-analysis comparing drug-eluting stent (DES) treatment with coronary artery bypass grafting (CABG) for patients with multivessel coronary artery disease. Our meta-analysis of trials (1 randomized, 24 nonrandomized) comparing CABG with DES treatment for multivessel coronary artery disease showed similar rates of all-cause mortality in the 2 groups but a lower incidence of major adverse cardiac and cerebrovascular events in the CABG group at 1 year and beyond.¹ The major contributor to the increased incidence of major adverse cardiac and cerebrovascular events seen in the DES group was the increased rate of repeat revascularization in that group.

Unlike our meta-analysis, in which unadjusted hazard ratios from the observational studies were used, Takagi and colleagues' analysis used adjusted hazard ratios to demonstrate significantly increased mortality in the DES group beyond 1 year. When trials including patients with 2-vessel disease and 3-vessel disease were pooled separately, no significant difference in mortality was seen.

These studies provide further evidence that CABG remains the standard of care for patients with multivessel coronary artery disease. In the 3-year outcomes of the Synergy

between Percutaneous Coronary Intervention with Taxus and Cardiac Surgery (SYNTAX) trial, presented at the 2010 European Association of Cardio-Thoracic Surgery meeting,² the incidence of major adverse cardiac and cerebrovascular events remained significantly greater among patients undergoing percutaneous coronary intervention than among those undergoing CABG. This was a result of greater rates of both repeat revascularization and myocardial infarction beyond 1 year in the former group.

Improvements in surgical revascularization are often overlooked. The main criticism of surgery in the SYNTAX trial (also shown in our meta-analysis) is the increased rate of perioperative stroke compared with percutaneous coronary intervention with DESs.^{1,3} There has been renewed interest in off-pump CABG, ideally without manipulation of the ascending aorta, in an attempt to decrease the rate of perioperative stroke. We have recently published a meta-analysis comparing off-pump CABG with percutaneous coronary intervention.⁴ The results suggest equivalent rates of stroke for off-pump CABG and percutaneous coronary intervention (unlike the SYNTAX results) but significantly lower rates of major adverse cardiac and cerebrovascular events in the surgical group. Debate surrounding the relative graft patencies of conventional CABG and off-pump CABG is ongoing. There is evidence, however, that when performed by surgeons experienced in the technically demanding technique, off-pump CABG achieves a graft patency equivalent to that of CABG.^{5,6}

The debate regarding CABG versus DES treatment is complex, and the goalposts are continually being shifted by evolving DES technology. This makes comparison of DES treatment with CABG difficult—perhaps indeed a Gordian knot in the question of myocardial revascularization. A solution, however, may not require the resurrection of Alexander the Great to cut the knot. Rather, well-

constructed trials (such as SYNTAX) and then a combined approach to decision making involving both cardiologists and surgeons will ensure selection of the most appropriate intervention for each patient and ultimately the best outcome.

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doi:10.1016/j.jtcvs.2011.03.027

SIMULATING VIDEO-ASSISTED THORACOSCOPIC LUNG RESECTION USING A VIRTUAL 3-DIMENSIONAL PULMONARY MODEL ON A PERSONAL COMPUTER

To the Editor:

We read the article by Solomon and associates,¹ “Simulating video-

assisted thoracoscopic lobectomy: A virtual reality cognitive task simulation,” with great interest. We agree with their virtual reality cognitive task simulation and think what they are doing is fantastic.

Video-assisted thoracic surgery has replaced open thoracotomy in the surgical treatment of many pleuropulmonary diseases.² Video-assisted thoracic surgery lobectomy has been gaining in popularity for early-stage lung cancer. On the other hand, anatomic variations of the pulmonary vessels present a potential risk of uncontrollable intraoperative bleeding; thus, it is necessary to collect information on the branching patterns of pulmonary vessels preoperatively.³

We previously described the virtual 3-dimensional pulmonary model on a personal computer (PC) for the preoperative simulation of video-assisted thoracoscopic lung resection.^{4,5} Our simulator has patient-specific anatomy incorporated.

In July 2001, we began using a virtual 3-dimensional pulmonary model on a PC in video-assisted thoracoscopic lung resection. A total of 140 patients underwent lobectomy and 158 patients underwent segmentectomy or subsegmentectomy for lung tumor.

By using 60 2-mm (at present 120 1-mm) high-resolution computed tomography images of the tumor and hilum, in DICOM format, we could mark on the pulmonary arteries, veins, bronchi, and tumor. We attempted to reconstruct these with anatomically correct images using a freeware program (CTTRY). After the images were uploaded to a PC, the pulmonary arteries, veins, and bronchi were traced in the images. The location and thickness of the bronchi and pulmonary vasculature were rendered as different-sized cylinders (Figure 1, A). Next, on the basis of the resulting numeric data, a 3-dimensional image (Figure 1, B) was reconstructed using shareware (Metasequoia). The reconstructed images can be manipulated