Concurrent Robotic Hybrid Revascularization Using an Enhanced Operative Suite*
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Hybrid myocardial revascularization combines coronary surgery with percutaneous intervention as an alternative therapy for ischemic heart disease. The order and sequence of the hybrid approach is not yet clearly defined. We report on the benefits of an enhanced surgical suite equipped with a carbon fiber operating table and digital C-arm for robotic-assisted hybrid revascularization in a single operative sequence. To our knowledge, this is the first reported case of concurrent robotic-assisted hybrid revascularization utilizing an enhanced operative suite. (CHEST 2005; 128:4046–4048)

Key words: angioplasty, transluminal, percutaneous coronary; coronary artery bypass; hybrid revascularization; methods; myocardial revascularization; robotics; surgical procedures, minimally invasive; therapies, investigational

Abbreviations: ICS = intercostal space; LAD = left anterior descending artery; LITA = left internal thoracic artery; PCI = percutaneous coronary intervention

Hybrid revascularization combines minimally invasive coronary artery bypass of the left internal thoracic artery (LITA) to the left anterior descending artery (LAD) with percutaneous coronary intervention (PCI) of other stenosed arteries.1 Hybrid revascularization is an alternative therapy for multivessel coronary artery disease in high-risk surgical patients in whom PCI is a poor option due to LAD disease location. The survival benefit of the LITA for ostial or complex lesions of the LAD is well established.2,3 Moreover, the advantage of venous grafts or radial artery grafts over PCI to treat low-grade lesions (< 70 to 80%) in other coronary arteries has been questioned.4 Together, this supports hybrid revascularization for a select group of patients.

As coronary surgery and PCI necessitate an operating room and a catheter laboratory, respectively, hybrid revascularization usually occurs in a two-step process over consecutive days. We report on the successful completion of robotic-assisted hybrid revascularization in a single operative sequence with an enhanced surgical suite (Fig 1).

CASE REPORT
A 64-year-old diabetic man with a history of liver transplantation, sigmoid colon resection, and renal insufficiency secondary to immunosuppressive medication was admitted for chest pain. Cardiac catheterization revealed mild hypokinesis in the anterolateral wall, evidence of a 95% ostial LAD stenosis, and an 80% stenosis in the right coronary artery. Due to the increased risk of infection, robotic-assisted minimally invasive hybrid myocardial revascularization was employed.

Under single-lung ventilation, the patient was placed in the 30° right lateral decubitus position. The da Vinci surgical system (Intuitive Surgical; Sunnyvale, CA) was positioned, and the endoscope was inserted at the fifth intercostal space (ICS) port anterior to the anterior axillary line. Electrosurgery and da Vinci DeBakey forceps (Intuitive Surgical) were inserted through the third and seventh ICS. The LITA was harvested from the first rib anterior to the anterior axillary line. Electrocautery and da Vinci endoscope was inserted at the fifth ICS port. LITA-LAD anastomosis was performed followed by successful PCI of the right coronary artery. There were no complications. The patient went home on postoperative day 6 and is angina free at 6 months.

DISCUSSION
Hybrid revascularization in a concurrent sequence has previously been proposed.5 However, other than two cases using a standard catheter laboratory in the series in which hybrid revascularization was first described,1 the concurrent hybrid approach has not been utilized due to the limitations of current-day surgical and interventional suites. The development of a hybrid surgical suite at our institution now facilitates hybrid revascularization in concurrent sequence. Immunosuppressive therapy increased the risk of our patient sustaining an infectious process from invasive surgical revascularization, while the location of the lesion at the ostium of the LAD suggested PCI to be...
a poor therapeutic option. The hybrid surgical suite provided the benefits of hybrid therapy with maximum efficiency.

Robotic-assisted LITA takedown was also utilized, evolving from minimal invasive direct coronary artery bypass used in the original description of hybrid revascularization. It is the experience at our institution that robotic assistance is a significant improvement over the minimally invasive direct coronary artery bypass approach. First, visualization within the thoracic cavity and of the LITA is noticeably better. This reduces the chance of injuring the LITA pedicle during takedown. As well, better visualization of the LAD lends to more appropriate placement of the thoracotomy for LITA-to-LAD anastomosis. For this reason, thoracotomy incisions have become considerably smaller. Second, surgical access is improved with robotic assistance, enabling mobilization of the entire LITA graft. Even when an ostial stenosis is the lesion of clinical concern, calcification is likely to be present throughout the entire LAD, and the anastomosis is preferably placed in the mid to distal third of the vessel. By increasing the length of the LITA, a greater area of the LAD is available for LITA-to-LAD anastomosis. This ensures the target anastomosis occurs with a tension-free LITA pedicle to an optimum location free of disease. Finally, robotic assistance negates the need for vigorous costal retraction. Although rare, the potential morbidity associated with costochondral dislocation and rib fracture is significant and would be even more so in an immunosuppressed patient receiving steroid therapy.

Concurrent hybrid revascularization ensures the survival benefits of the LITA graft, reduces the morbidity associated with conventional surgery (eliminates sternotomy incisions and cardiopulmonary bypass), and minimizes patient inconvenience and anesthetic exposure by using a single operative approach. The potential reduction in hospital costs from more efficient use of operating rooms and catheter laboratories, along with shorter hospital stays for the patient in comparison to a two-step hybrid approach, makes the concurrent approach ideal.

**Conclusion**

Robotic hybrid revascularization in concurrent sequence utilizing an enhanced surgical suite is both efficient and feasible. Further studies are indicated.

**References**

2. Hueb WA, Bellatti G, de Oliveira SA, et al. Late follow-up of 781 patients undergoing percutaneous transluminal coronary angioplasty or coronary artery bypass grafting for an isolated

**Figure 1.** Image of the enhanced operative suite depicting the orientation of the carbon fiber operating table, digital C-arm, and daVinci telemanipulation system in relation to one another. Display monitors in the background move to a central position to facilitate angiographic imaging.
obstruction in the left anterior descending coronary artery. Am Heart J 1989; 118:1144–1153